PROJECT MANUAL

TM Aviation Hangar at LXT

Lee's Summit, Missouri

Prepared by
Wellner Architects + Engineers, Inc

Lee's Summit
Lee's Summit Missouri 64064
Project Number 2404

SECTION 00 01 01 - PROJECT TITLE PAGE

PART 1 - GENERAL

1.1 PROJECT MANUAL

A. VOLUME Review Set - Not for Construction.

1. TM Aviation Hangar at LXT.
2. .
3. 2310 S Redwood Ave - Independence, MO 64057.
4. Architect Project No. 2404.
5. Wellner Architects + Engineers.
6. 1627 Main St., #100 - Kansas City, MO 64108.
7. Phone: 816-221-0017.
8. Website: https://www.wellner.com/.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF SECTION 00 01 01

DOCUMENT 00 01 07 - SEALS PAGE

PART 1 - GENERAL

1.1 DESIGN PROFESSIONALS OF RECORD

A. Architect:

1. Wellner Architects + Engineers
2. Responsible for Sections:

    a. Divisions 01-13 Sections except where indicated as prepared by other design professionals of record.

3. Responsible for Drawings:

    a. G-000, G-005, G-006, G-007, G-008, AS100, A-100, A-102, A-103, A-104, A-201, A-301, A-302, A-310, A-311, A-312, A-401, A-501, A-502, A-601, A-701, A-702.

Civil Engineer:

4. Crawford, Murphy & Tilly.
5. Responsible for Sections:

    a. 012200, 2101, 2102, 2103, 2104, 2150, 2151, 2152, 2153, 2154, 2156, 2200, 2201, 2202, 2203, 2204,2205, 2206, 2207, 2208, 2209, 2211, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2700, 2701, 2702, 2800, 3500, 3501, 3502, 3503, 3900, 3901, 3902, 3903.

6. Responsible for Drawings:

    a. G-001, G-002, G-003, G-004, C-101, C-102, C-103, C-104, C-105, C-106, C-107, C-108, C-109, C-110, C-111, C-112, C-113, C-114, C-115, C-116, C-117, C-118, C-119, C-120, C-121, C-122, C-123, C-124, C-125, C-126, C-127, C-128 C-129, C-130, C-131, C-132, C-133, C-134, C-13.

7. 

Gerald T. Bollinger

Landscape Architect:

8. Olsson.
9. Responsible for Drawings:

    a. L100.

B. Structural Engineer:

1. Professional Engineering Consultants.
2. Responsible for Sections:

    a. Section 033000 – Cast-in-place Concrete
    b. Section 042200 – Concrete Unit Masonry
    c. Section 051200 – Structural Steel Framing
    d. Section 053100 – Steel Decking
    e. Section 133419 – Metal Building Systems.

3. Responsible for Drawings:

    a. S-000 Structural Cover Sheet
    b. S-001 General Notes
    c. S-002 IBC Inspection Tables
    d. S-101 Foundation Plan
    e. S-501 Typical Foundation Details
    f. S-502 Foundation Details
    g. S-521 Framing Details.

Fire Protection, Mechanical, Plumbing and Electrical Engineer:

4. Wellner Architects + Engineers
5. Responsible for Sections:

    a. Divisions 21-28

6. Responsible for Drawings:

    a. ME000, ME001, ME002, ME003, ME004, FP100, P-100, P-110, P-400, P-410, P-500, M-100, M-110, M-200, M-300, M-310, M-400, M-410, M-500, E-100, E-110, E-120, E-130, E-300, E400, E-410, E-420, E-500, E510

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF DOCUMENT 000107

TABLE OF CONTENTS

DOCUMENT 00 01 15 - LIST OF DRAWING SHEETS

PART 1 - GENERAL

1.1 LIST OF DRAWINGS

A. Drawings: Drawings that will be enumerated in the Owner/Contractor Agreement as part of the Contract Documents are listed on the Table of Contents page of the separately bound drawing set titled TM Aviation Hangar at LXT - Drawings, dated March 21, 2025, as modified by subsequent Addenda and Modifications.

1. The words "Resource Drawing" or "For information" after the titles of drawings indicate that those drawings are not intended to be incorporated in the Contract Documents.

B. List of Drawings: Drawings that will be enumerated in the Owner/Contractor Agreement as part of the Contract Documents are the following Drawings and other drawings of type indicated, as modified by subsequent Addenda and Modifications:

G-000	COVER
G-001	SOQ
G-002	CONSTRUCTION ACTIVITY PLAN
G-003	CAP NOTES
G-004	TRAFFIC CONTROL DETAILS
G-005	CODE PLAN
G-006	WALL TYPES
G-007	GENERAL ACCESSIBILITY
G-008	INTERIOR ACCESSIBILITY
C-101	EXISTING CONDITIONS AND DEMOLITION
C-102	TYPICAL SECTIONS PLAN VIEW
C-103	TYPICAL SECTIONS SHEET 1 OF 2
C-104	TYPICAL SECTIONS SHEET 2 OF 2
C-105	SITE PLAN
C-106	SITE DETAILS
C-107	PAVING PLAN
C-108	AIRFIELD JOINTING PLAN
C-109	AIRFIELD JOINTING DETAILS
C-110	PARKING LOT JOINTING PLAN
C-111	PAVEMENT JOINTING DETAILS 1 OF 2
C-112	PAVEMENT JOINTING DETAILS 2 OF 2
C-113	GRADING PLAN
C-114	STAKING PLAN
C-115	UTILITY PLAN
C-116	SANITARY SEWER PROFILE
C-117	SANITARY SEWER DETAILS
C-118	WATERLINE DETAILS
C-119	WATERLINE PROFILE SHEET 1 OF 2
C-120	WATERLINE PROFILE SHEET 2 OF 2
C-121	ELECTRICAL PLAN

C-122	ELECTRICAL DETAILS
C-123	FENCING PLAN
C-124	FENCING DETAILS
C-125	SLIDING GATE DETAILS 1 OF 5
C-126	SLIDING GATE DETAILS 2 OF 5
C-127	SLIDING GATE DETAILS 4 OF 5
C-128	SLIDING GATE DETAILS 3 OF 5
C-129	SLIDING GATE DETAILS 5 OF 5
C-130	EROSION CONTROL PLAN
C-131	EROSION CONTROL DETAILS
C-132	AIRFIELD MARKING PLAN
C-133	PARKING LOT MARKING PLAN
C-134	MARKING & SIGNAGE DETAIL 1 OF 2
C-135	MARKING & SIGNAGE DETAIL 2 OF 2
L-100	OVERALL LANDSCAPE PLAN
S-000	STRUCTURAL COVER SHEET
S-001	GENERAL NOTES
S-002	IBC INSPECTION TABLES
S-101	FOUNDATION PLAN
S-501	TYPICAL FOUNDATION DETAILS
S-502	FOUNDATION DETAILS
S-521	FRAMING DETAILS
AS100	ARCHITECTURAL SITE PLAN
A-100	FLOOR PLANS
A-102	ENLARGED PLAN
A-103	OVERALL REFLECTED CEILING PLAN
A-104	ROOF PLAN
A-201	EXTERIOR ELEVATIONS
A-301	BUILDING SECTIONS
A-302	BUILDING SECTIONS
A-310	WALL SECTIONS
A-311	WALL SECTIONS
A-312	WALL SECTIONS
A-401	VERTICAL CIRCULATION STAIRS
A-501	DETAILS
A-502	DETAILS
A-601	INTERIOR ELEVATIONS
A-701	DOOR SCHEDULE & LEGEND
A-702	STOREFRONT ELEVATIONSP-100 PLUMBING PLANS
P-400	PLUMBING DETAILS
P-410	PLUMBING DETAILS
P-500	PLUMBING SCHEDULES
M-100	MECHANICAL PLANS
M-110	RADIANT FLOOR MECHANICAL PLANS
M-200	MECHANICAL PIPING PLANS
M-300	MECHANICAL DIAGRAMS
M-310	MECHANICAL DIAGRAMS
M-400	MECHANICAL DETAILS
M-410	MECHANICAL DETAILS
M-500	MECHANICAL SCHEDULES
ME000	MECHANICAL/ELECTRICAL SYMBOLS LEGEND

ME001	MECHANICAL / ELECTRICAL GENERAL NOTES
ME002	MEP SITE PLAN
ME003	SITE LIGHTING PHOTOMETRIC PLAN
ME004	SITE WORK MEP DETAILS
E-100	LIGHTING PLAN
E-110	POWER PLAN
E-120	SPECIAL SYSTEMS PLAN
E-130	ROOF LIGHTNING PROTECTION PLAN
E-300	ELECTRICAL ONE-LINE DIAGRAM
E-310	FIRE ALARM RISER AND DETAILS
E-400	ELECTRICAL DETAILS
E-410	ELECTRICAL DETAILS
E-420	ELECTRICAL DETAILS
E-500	ELECTRICAL SCHEDULES
E-510	ELECTRICAL SCHEDULES
FP100	FIRE PROTECTION PLANS

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF DOCUMENT 00 01 15

DOCUMENT 00 11 16 - INVITATION TO BID

PART 1 - GENERAL

1.1 PROJECT INFORMATION

A. Notice to Bidders: Selected Bidders are invited to submit Bids for Project as described in this Document in accordance with the Instructions to Bidders.

B. Project Identification: TM Aviation Hangar at LXT

1. Project Location: Kansas City/Lee's Summit Regional Airport

C. Owner: TMA Aviation, LLC

TMA Aviation LLC
2310 S Redwood Ave.
Independence, Mo 64057

D.

Owner's Representative: Ken Denning

Ken Denning
Director of Operations & Maintenance.
N900BFChief Pilot
TMAviationllc@gmail.com
816-536-1852

E. Architect: Wellner Architects + Engineers

Jason Barker AIA, LEED AP
Principal, Architecture
jason@wellner.com
816.381.9047

F. Project Description: Project consists of new 90' x 130' aircraft hangar with office space. Adjacent parking lot with security fence. Aircraft apron and taxiway. Utilities from public right of way to the building. Modification of existing airport perimeter fence.

G. Construction Contract: Bids will be received for the following Work:

1. General Contract (all trades).

1.2 BID SUBMITTAL AND OPENING

A. Bid Submittal, Electronic: Owner will receive electronically submitted Bids until the bid time and date via web-based bidding management software. Owner will consider Bids prepared in compliance with the Instructions to Bidders and delivered as follows:

1. Bid Date: ~~April 11, 2025~~ ~~*April 18, 2025*~~ **April 25, 2025**
2. Bid Time: Not later than 2:00 p.m., local time.
3. Bids will be thereafter opened and privately opened.

1.3 BID SECURITY

A. Submit bid security with each Bid in the stipulated form and in the amount identified in the Instructions to Bidders.

B. Bid security shall be submitted with each bid in the amount of 5 percent of the bid amount. No bids may be withdrawn for a period of 60 days after opening of bids. Owner reserves the right to reject any and all bids and to waive informalities and irregularities.

1.4 BIDDERS QUESTIONS

A. Bidders' Questions: Submit requests for clarification and interpretation using method indicated in Instructions to Bidders.

1.5 BIDDING DOCUMENTS

A. Bidding Documents, Electronic: Obtain access after March 21, 2025. Contacting Architect. Online access will be provided to all registered Bidders and Sub-Bidders and suppliers.

1.6 TIME OF COMPLETION

A. By submitting a Bid, Bidder represents that Bidder will begin the Work on receipt of the Notice to Proceed and will complete the Work within the Contract Time indicated in the Bidding Documents.

1.7 BIDDER'S QUALIFICATIONS

A. Licenses: Bidders must be properly licensed under the laws governing their respective trades.

B. Insurance and Bonds: A Performance Bond, separate Labor and Material Payment Bond, and insurance in a form acceptable to Owner will be required of the successful Bidder.

C. Contractor's Qualification Statement: A completed AIA Document A305, "Contractor's Qualification Statement," with all exhibits is required to be submitted with the bid.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF DOCUMENT 00 11 16

DOCUMENT 00 21 13 - INSTRUCTIONS TO BIDDERS

PART 1 - GENERAL

1.1 INSTRUCTIONS TO BIDDERS

A. AIA Document A701-2018, "Instructions to Bidders," is hereby incorporated into the Bidding Documents by reference.

1. A copy of AIA Document A701-2018, "Instructions to Bidders," is bound in this Project Manual.
2. Document 002213 "Supplementary Instructions to Bidders" is bound in this Project Manual.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF DOCUMENT 00 21 13

DOCUMENT 00 22 13 - SUPPLEMENTARY INSTRUCTIONS TO BIDDERS

PART 1 - GENERAL

1.1 INSTRUCTIONS TO BIDDERS

A. Instructions to Bidders for Project consist of the following:

1. AIA Document A701-2018, "Instructions to Bidders," a copy of which is bound in this Project Manual.
2. The following Supplementary Instructions to Bidders that modify and add to the requirements of the Instructions to Bidders.

1.2 SUPPLEMENTARY INSTRUCTIONS TO BIDDERS, GENERAL

A. The following supplements modify AIA Document A701-2018, "Instructions to Bidders." Where a portion of the Instructions to Bidders is modified or deleted by these Supplementary Instructions to Bidders, unaltered portions of the Instructions to Bidders will remain in effect.

1.3 ARTICLE 2 - BIDDER'S REPRESENTATIONS

A. Add the following to 2.1:

1. .7 The Bidder has investigated all required fees, permits, and regulatory requirements of authorities having jurisdiction and has properly included in the submitted bid the cost of such fees, permits, and requirements not otherwise indicated as provided by Owner.
2. .8 The Bidder is a properly licensed Contractor according to the laws and regulations of the State of Missouri and the City of Lee's Summit and meets qualifications indicated in the Bidding Documents.
3. .9 The Bidder has incorporated into the Bid adequate sums for work performed by Installers whose qualifications meet those indicated in the Bidding Documents.

1.4 ARTICLE 3 - BIDDING DOCUMENTS

A. 3.1 - Distribution:

1. Add the following to 3.1.1:

a. Obtain electronic Bidding Documents as instructed in the Advertisement for Bids.

B. 3.2 - Modification or Interpretation of Bidding Documents:

1. Add the following to 3.2.2:

    a. Submit Bidder's Requests for Interpretation using form furnished with electronic bid forms and submitted via email.

C. 3.4 - Addenda:

1. Add the following to 3.4.1:

    a. Addenda will be transmitted by the issuing office via email.

2. Delete 3.4.3 and replace with the following:

    a. 3.4.3 Addenda may be issued at any time prior to the receipt of bids.

1.5 ARTICLE 4 - BIDDING PROCEDURES

A. 4.1 - Preparation of Bids:

1. Add the following to 4.1.1:

    a. Printable electronic Bid Forms and related documents are available from Architect.

2. Add the following to 4.1.8:

    a. The Bid shall include unit prices when called for by the Bidding Documents. Owner may elect to consider unit prices in the determination of award. Owner may elect to incorporate unit prices in the Contract.

3. Add the following to 4.1:

    a. 4.1.9 Owner may elect to disqualify a bid due to failure to submit a bid in the form requested, failure to bid requested alternates or unit prices, failure to complete entries in all blanks in the Bid Form, or inclusion by the Bidder of any alternates, conditions, limitations or provisions not called for.
    b. 4.1.10 Bids shall include sales and use taxes. Contractors shall show separately with each monthly payment application the sales and use taxes paid by them and their subcontractors in the form indicated. Reimbursement of sales and use taxes, if any, shall be applied for by Owner for the sole benefit of Owner.

B. 4.2 - Bid Security:

1. Add the following to 4.2.1:

    a. Provide bid security in the amount of 5 percent of the bid amount in the form of a cashier's check or surety bond meeting the requirements of 4.2.3.

C. 4.3 - Submission of Bids:

1. Add the following to 4.3.1:

    a. Submit electronic bids using PDF and emailing to Owner and Architect.

D. 4.4 - Modification or Withdrawal of Bids:

1. Add the following to 4.4.1:

    a. .1 Such modifications to or withdrawal of a bid may only be made by persons authorized to act on behalf of the Bidder. Authorized persons are those so identified in the Bidder's corporate bylaws, specifically empowered by the Bidder's charter or similar legally binding document acceptable to Owner, or by a power of attorney, signed and dated, describing the scope and limitations of the power of attorney. Make such documentation available to Owner at the time of seeking modifications or withdrawal of the Bid.

E. 4.5 - Break-Out Pricing Bid Supplement:

1. Add 4.5.
2. Add the following to 4.5:

    a. 4.5.1 Provide detailed cost breakdowns no later than two business days following Architect's request.

F. 4.6 - Subcontractors, Suppliers, and Manufacturers List Bid Supplement:

1. Add 4.6.
2. Add the following to 4.6:

    a. 4.6.1 Provide list of major subcontractors, suppliers, and manufacturers furnishing or installing products no later than two business days following Architect's request. Include those subcontractors, suppliers, and manufacturers providing Work totaling three percent or more of the Bid amount. Do not change subcontractors, suppliers, and manufacturers from those submitted without approval of Architect.

1.6 ARTICLE 5 - CONSIDERATION OF BIDS

A. 5.2 - Rejection of Bids:

1. Add the following to 5.2:

    a. 5.2.1 Owner reserves the right to reject a bid based on Owner's and Architect's evaluation of qualification information submitted following opening of bids. Owner's evaluation of the Bidder's qualifications will include: status of licensure and record of compliance with licensing requirements, record of quality of completed Work, record of Project completion and ability to complete, record of financial management including financial resources available to complete Project and record of

timely payment of obligations, record of Project site management including compliance with requirements of authorities having jurisdiction, record of and number of current claims and disputes and the status of their resolution, and qualifications of the Bidder's proposed Project staff and proposed subcontractors.

1.7 ARTICLE 6 - POSTBID INFORMATION

A. 6.1 - Contractor's Qualification Statement:

1. Add the following to 6.1:

~~a.~~ 6.1.1 Submit Contractor's Qualification Statement ~~no later than two business days following Architect's request.~~ **with the bid.**

B. 6.3 - Submittals:

1. Add the following to 6.3.1:

a. .4 Submit information requested in 6.3.1. no later than two business days following Architect's request.

1.8 ARTICLE 7 - PERFORMANCE BOND AND PAYMENT BOND

A. 7.1 - Bond Requirements:

1. Add the following to 7.1.1:

a. .1 Both a Performance Bond and a Payment Bond will be required, each in an amount equal to 100 percent of the Contract Sum.

B. 7.2 - Time of Delivery and Form of Bonds:

1. Replace the first sentence of 7.2.1 with the following:

a. The Bidder shall deliver the required bonds to Owner no later than 10 days after the date of a Notice of Intent to Award and no later than the date of execution of the Contract, whichever occurs first. Owner may deem the failure of the Bidder to deliver required bonds within the period of time allowed a default.

2. Replace 7.2.3 with the following:

a. 7.2.3 Bonds shall be executed and be in force on the date of the execution of the Contract.

1.9 ARTICLE 8 - ENUMERATION OF THE PROPOSED CONTRACT DOCUMENTS

A. 8.1 - Proposed Contract Documents:

1. Replace .5 in 8.1 with the following:

    a. .5 Enumeration of Drawings: The Drawings constituting a portion of the proposed Contract Documents are identified on the Cover Sheet or Title Sheet of the Drawings titled TM Aviation Hangar at LXT - Drawings dated <**Insert Drawings issue date**>.

2. Replace .6 in 8.1 with the following:

    a. .6 Enumeration of Specifications: The Specifications constituting a portion of the proposed Contract Documents are identified on the Table of Contents Sheet of the Project Manual titled TM Aviation Hangar at LXT - Project Manual dated <**Insert Project Manual issue date**>.

3. Replace .7 in 8.1 with the following:

    a. .7 Addenda: Portions of the Addenda constituting a portion of the proposed Contract Documents will be enumerated in the Owner/Contractor Agreement.

4. Replace .8 in 8.1 with the following:

    a. .8 Other Exhibits: Other Exhibits constituting portions of the proposed Contract Documents will be identified in the Bidding Documents and be enumerated in the Owner/Contractor Agreement.

1.10 ARTICLE 9 - EXECUTION OF THE CONTRACT

A. Add Article 9.

B. Add the following to Article 9:

1. 9.1 Subsequent to the Notice of Intent to Award, and within 10 days after the prescribed Form of Agreement is presented to the Awardee for signature, the Awardee shall execute and deliver the Agreement to Owner through Architect, in such number of counterparts as Owner may require.
2. 9.2 Owner may deem as a default the failure of the Awardee to execute the Contract and to supply the required bonds when the Agreement is presented for signature within the period of time allowed.
3. 9.3 Unless otherwise indicated in the Bidding Documents or the executed Agreement, the date of commencement of the Work shall be the date of the executed Agreement or the date that the Bidder is obligated to deliver the executed Agreement and required bonds to Owner.
4. 9.4 In the event of a default, Owner may declare the amount of the Bid security forfeited and elect to either award the Contract to the next responsible bidder or re-advertise for bids.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF DOCUMENT 00 22 13

DOCUMENT 00 26 00 - PROCUREMENT SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 DEFINITIONS

A. Procurement Substitution Requests: Requests for changes in products, materials, equipment, and methods of construction from those indicated in the Procurement and Contracting Documents, submitted prior to receipt of bids in accordance with Instructions to Bidders.

B. Procurement Prior Approval Requests: Requests for approval of products or manufacturers from those required by the Contract Documents as defined by product selection procedures in Section 016000 "Product Requirements."

1. Procurement prior approval is required when products or manufacturers are listed in specifications under "Sole Product," "Sole Manufacturer," "Limited List of Products," or "Limited List of Manufacturers" introductory paragraphs.
2. Procurement prior approval is not required when products or manufacturers are listed in specifications under "Non-Limited List of Products" or "Non-Limited List of Manufacturers" introductory paragraphs.
3. Where use of "Sole Product," "Sole Manufacturer," "Limited List of Products," or "Limited List of Manufacturers" introductory paragraphs is not allowed by statute, procurement prior approval request is not required.

C. Substitution Requests: Requests for changes in products, materials, equipment, and methods of construction from those indicated in the Contract Documents, submitted following Contract award. See the General Conditions and Section 012500 "Substitution Procedures" for conditions under which Substitution requests will be considered following Contract award.

1.2 QUALITY ASSURANCE

A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.3 PROCUREMENT SUBSTITUTIONS

A. Procurement Substitutions, General: By submitting a bid, the Bidder represents that its bid is based on materials and equipment described in the Procurement and Contracting Documents, including Addenda. Bidders are encouraged to request approval of qualifying substitute materials and equipment when the Specifications Sections list materials and equipment by product or manufacturer name.

B. Procurement Substitution Requests will be received and considered by Owner when the following conditions are satisfied, as determined by Architect; otherwise requests

will be returned without action:

1. Extensive revisions to the Contract Documents are not required.
2. Proposed changes are in keeping with general intent of the Contract Documents, including level of quality of the Work represented by requirements therein.
3. Request is fully documented and properly submitted.

1.4 SUBMITTALS

A. Procurement Substitution Request: Submit to Architect. Procurement Substitution Request must be made in writing in compliance with the following requirements:

1. Requests for substitution of materials and equipment will be considered if received no later than 10 days prior to date of bid opening.
2. Submittal Format, Printed: Submit three copies of each written Procurement Substitution Request, using form bound in Project Manual or CSI Substitution Request Form 1.5C.
3. Submittal Format, Electronic: Submit Procurement Substitution Request, using format provided on Project web-based bidding management software site.

    a. Identify the product or the fabrication or installation method to be replaced in each request. Include related Specifications Sections and Drawing numbers.
    b. Provide complete documentation on both the product specified and the proposed substitute, including the following information as appropriate:

        1) List of similar installations for completed projects, with project names and addresses as well as names and addresses of architects and owners.
        2) Product data, including drawings and descriptions of products and fabrication and installation procedures.
        3) Point-by-point comparison of specified and proposed substitute product data, fabrication drawings, and installation procedures.
        4) Copies of current, independent third-party test data of salient product or system characteristics.
        5) Samples where applicable or when requested by Architect.
        6) Detailed comparison of significant qualities of proposed substitute with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
        7) Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
        8) Research reports, where applicable, evidencing compliance with building code in effect for Project, from ICC-ES.
        9) Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors, which will become necessary to accommodate proposed substitute.

c. Provide certification by manufacturer that proposed substitute is equal to or superior to that required by the Procurement and Contracting Documents, and that its in-place performance will be equal to or superior to product or equipment specified in the application indicated.
d. Bidder, in submitting the Procurement Substitution Request, waives the right to additional payment or an extension of Contract Time because of the failure of substitute to perform as represented in the Procurement Substitution Request.

B. Architect's Action:

1. Architect may request additional information or documentation necessary for evaluation of the Procurement Substitution Request. Architect will notify all Bidders of acceptance of proposed substitute by means of an Addendum to the Procurement and Contracting Documents.

C. Architect's approval of substitute during bidding does not relieve Contractor of the responsibility to submit required Shop Drawings and to comply with all other requirements of the Contract Documents.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF DOCUMENT 00 26 00

DOCUMENT 00 26 01 - REQUEST FOR SUBSTITUTION FORM, BIDDING PHASE

PART 1 - GENERAL

1.1 SUMMARY

A. Prime Bidders: Use this form to request consideration of an unnamed manufacturer, an unnamed product, or an alternative fabrication method prior to submittal of bids when use of specific manufacturers, products, or fabrications methods are required by the Specifications.

B. See Document 002600 "Procurement Substitution Procedures" for instructions for submittal of this form and for definitions used on this form.

C. This form is not required to be submitted when named products are introduced by the phrase "Available products include…" unless the intended product differs substantially from the requirements of the Contract Documents.

D. Response to this request by Architect will be in the form of a written response to the Bidder and, if approved, by Addendum issued to all Bidders.

1.2 PROJECT INFORMATION

A. Project Name: TM Aviation Hangar at LXT.

B. Owner: TM Aviation.

C. Architect: Wellner Architects + Engineers.

D. Architect Project Number: 2404.

1.3 BIDDING REQUEST INFORMATION

A. Bidder: _____. Email: _____.

B. Specification Section No.: _____.

1.4 SPECIFIED PRODUCT

A. Specified Product/Fabrication Method (List Name, Description, Model Number, and Manufacturer): _____.

B. Specified Product Information (Attach Point-by-Point Data to This Form):

1. ▢ Point-by-point comparative product data.
2. ▢ Test reports.
3. ▢ Fabrication drawings.
4. ▢ Samples (where applicable).

1.5 PROPOSED PRODUCT

A. Specified Product/Fabrication Method (List Name, Description, Model Number, and Manufacturer):

_____.

B. Proposed Product Information (Attach Point-by-Point Data to This Form):

1. ▢ Point-by-point comparative product data.
2. ▢ Test reports.
3. ▢ Fabrication drawings.
4. ▢ Samples (where applicable).

1.6 IMPACT OF PROPOSED SUBSTITUTION

A. List of Related Changes Required by Substitution: ▢ None. Explain:

_____
.

B. Differences between Specified Product and Proposed Substitution: ▢ None. Explain:

_____
.

C. Proposed Product/Fabrication Method Effects on Other Parts of the Work: ▢ None. Explain:

_____
.

D. Proposed Product/Fabrication Method Effects on the Contract Time: ▢ None. Explain:

_____
.

1.7 CERTIFICATION

A. Undersigned certifies the following:

1. Proposed substitution has been investigated by the Bidder and determined to be equal or superior to specified product as used for this Project, except as noted herein.
2. Qualifications of manufacturer, Installer, and other specified parties meet the specified qualifications.
3. Same warranty will be furnished for proposed substitution as for specified product, if applicable.

4. Same maintenance service and availability of replacement parts as for specified product, if applicable.
5. Proposed substitution does not affect dimensions and functional clearances, except as noted herein.
6. Proposed substitution will not affect the Contract Time.
7. Proposed substitution will not affect work of other trades.
8. Proposed substitution provides comparable sustainable design properties as specified product, if applicable.

1.8 SUBMISSION OF REQUEST FOR SUBSTITUTION

A. For the Bidder:

1. Submittal Date:
_____.
2. Firm Name:
_____.
3. Submitted by:
_____.
4. Email:
_____
_.

B. For Manufacturer:

1. Submittal Date:
_____.
2. Firm Name:
_____.
3. Submitted by:
_____.
4. Email:
_____
_.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF DOCUMENT 00 26 01

DOCUMENT 00 31 32 - GEOTECHNICAL DATA

PART 1 - GENERAL

1.1 GEOTECHNICAL DATA

A. This Document, with its referenced attachments, is part of the Procurement and Contracting Requirements for the Project. They provide Owner's information for Bidders' convenience and are intended to supplement rather than serve in lieu of Bidders' own investigations. They are made available for Bidders' convenience and information. This Document and its attachments are not part of the Contract Documents.

B. Because subsurface conditions indicated by the soil borings are a sampling in relation to the entire construction area, and for other reasons, Owner, Architect, Architect's consultants, and the firm reporting the subsurface conditions do not warranty the conditions below the depths of the borings or that the strata logged from the borings are necessarily typical of the entire site. Any party using the information described in the soil borings and geotechnical report accepts full responsibility for its use.

C. A Geotechnical Investigation Report for Project, prepared by Kruger Technologies, Inc., dated October 1, 2024, is available for viewing as appended to this Project Manual.

1. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from the data.
2. Any party using information described in the geotechnical report will make additional test borings and conduct other exploratory operations that may be required to determine the character of subsurface materials that may be encountered.

D. Related Requirements:

1. Document 002113 "Instructions to Bidders" for the Bidder's responsibilities for examination of Project site and existing conditions.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF DOCUMENT 00 31 32

REPORT OF GEOTECHNICAL EXPLORATION
LEE'S SUMMIT MUNICIPAL AIRPORT SOUTH HANGAR
LEE'S SUMMIT, MISSOURI

Presented to:

Ms. Julie Wellner, AIA
WELLNER ARCHITECTS + ENGINEERS

Prepared by:

Otto J. Kruger, Jr., P.E.

Kruger Technologies, Inc.
Lenexa, Kansas

KTI Project No. 224158G

October 1, 2024

KRUGER TECHNOLOGIES, INC.

GEOTECHNICAL ▪ ENVIRONMENTAL ▪ TESTING ▪ INSPECTION
8271 MELROSE DRIVE ▪ LENEXA, KANSAS 66214 ▪ VOICE 913-498-1114 ▪ FAX 913-498-1116 ▪ EMAIL KTIKC@KTIONLINE.COM

October 1, 2024

Ms. Julie Wellner, AIA
Wellner Architects + Engineers
1672 Main St., Suite # 100
Kansas City, MO 64108

Re: KTI Project No. 224158G
Lee's Summit Municipal Airport South Hangar
Lee's Summit, Missouri

Dear Ms. Wellner:

Kruger Technologies, Inc. (KTI) has completed the subsurface exploration and geotechnical report for the above referenced project. The purpose of this report was to describe the surface and subsurface conditions encountered at the site, analyze and evaluate this information, and prepare a summary of existing conditions including subsurface material characteristics and to give site specific geotechnical design recommendations.

We thank you for the opportunity to work with Wellner Architects + Engineers. If you have any questions, please contact us at 913.498.1114.

Respectfully submitted,
Kruger Technologies, Inc.

Otto J. Kruger, Jr., P.E.
Missouri.: 23994

TABLE OF CONTENTS

REPORT OF GEOTECHNICAL EXPLORATION
LEE'S SUMMIT MUNICIPAL AIRPORT SOUTH HANGAR
LEE'S SUMMIT, MISSOURI

AUTHORIZATION

The following table presents the authorization documentation history for the work performed and presented in this report by Kruger Technologies, Inc.

Project: Lee's Summit Municipal Airport South Hangar in Lee's Summit, Missouri		
Document:	**Date:**	**Requested/Provided:**
Request for Proposal	4-4-24	Julie Wellner – Wellner Architects
KTI Proposal 24GT069	4-6-24	Dylan Kruger – Kruger Technologies, Inc.
Notice to Proceed	8-27-24	Julie Wellner – Wellner Architects

PURPOSE AND SCOPE

The purpose of this investigation was to explore the surface and subsurface conditions present within the site and provide recommendations regarding the following:

- Seismic Considerations
- Site Preparation and Engineered Fill
- Lateral Earth Pressure
- Foundation Options
- Slab on Grade
- Surface Drainage
- Excavation Considerations
- Trench Backfill Recommendations
- Manhole/Inlet Structure Backfill Recommendations
- Pavement Recommendations

SITE CONDITIONS

The proposed new 11,700 square foot single story hangar structure site is located to the west of the intersection of NE Leinweber Road and NE Hagan Road within the existing Lee's Summit Municipal Airport in Lee's Summit, Missouri. At the time of the investigation the proposed site was undeveloped, generally flat, grass covered, with a new hangar facility under construction to the north of the proposed hangar building.

PROJECT DESCRIPTION

The project consists of the design and construction of an 11,700 square foot single story hangar structure, apron and related site improvements and pavements to be built to the west of the intersection of NE Leinweber Road and NE Hagan Road in Lee's Summit, Missouri. No building load or structure type information was available at the time of this report preparation. Based on our observation on the proposed site topography and no identified finish floor elevations for any of the buildings, we have assumed that minimal cut and fill operations are intended at the building pad areas.

FIELD EXPLORATION PROCEDURES

Eight (8) test borings for the building, drive, parking and site areas were completed on September 8, 2024. The number and location of borings were selected by the client and field located by KTI based on the plan provided by the client. The boring locations are shown on the attached Boring Location Diagram. Depths indicated on the boring logs are referenced from the ground surface at the time of the exploration.

The borings were drilled using a Geoprobe 8772GT drill rig. Advancement of the test holes was accomplished using 4-inch hollow stem augers. Soil sampling was performed by hydraulically pushing thin wall steel (Shelby) tubes and Split Spoon Test (SPT).

Site soils were visually and manually classified in general accordance with ASTM D 2488 by the drill crew chief as drilling progressed. The soil samples collected in the field were delivered to the laboratory for applicable testing and verification of the field classifications. The boring logs were created as the borings advanced, and the logs were supplemented with information from the laboratory tests to present data concerning the depth and classification of the various strata, water levels, and other pertinent information. The boring logs are attached in Appendix I.

Groundwater was not encountered at any test borings. It should be noted that water level determinations made in relatively impervious (clay) soils might not present a reliable indication of the actual water table. However, water level determinations made in relatively pervious (sand/silt) soils are considered an accurate indication of the water table at the time that those measurements are made. Fluctuations in the water table should be expected with changing seasons and annual differences.

LABORATORY TESTS

Laboratory tests were performed on the recovered samples to determine the engineering characteristics and for additional verification of the field classifications in accordance with ASTM D 2487. The results of these tests, including moisture/density, plasticity (Atterberg Limits) and unconfined compressive strength of soil are presented in Appendix II.

GEOLOGY/SUBSURFACE CONDITIONS

The topsoil encountered was generally 6 to 12 inches thick. Below the topsoil, the site native soils encountered were approximately 7.5 to 8.5 feet thick. The site native soils are comprised predominantly of low plasticity clays (CL) and high plasticity clays (CH). The site native soil was generally medium stiff to very stiff consistency and moist. Weathered shale bedrock material was encountered below the site native soils at depths ranging from 9.0 to 9.5 feet below existing grade. As previously stated, free groundwater was not encountered at any test borings.

DESIGN CRITERIA AND RECOMMENDATIONS

Laboratory test results of the recovered samples showed the following characteristics that were used as criteria for determining the recommendations for bearing values and design data:

Natural Dry Density ……100.9 to 113.3 pcf
Natural Moisture Content ……..8.5 to 22.3%
Liquid Limit……43 to 60
Plastic Limit……...22 to 36
Unconfined Compressive Strength of soil (Building).....…….9,883 to 10,523 psf
Unconfined Compressive Strength of soil (Parking & Apron)…6,411 to 14,890 psf

Seismic Considerations

Based on the International Building Code (IBC) Section 1613.1, the subsurface stratigraphy, and the use of a shallow foundation system bearing on site native soils, the general Site Class Definition for the project area is Site Class C.

Site Preparation and Engineered Fill

Areas to receive fill should be stripped of vegetation, topsoil, and any other deleterious materials. Any isolated areas of soft or deleterious materials encountered at subgrade elevation should be removed and replaced with engineered fill. The moisture content of the subgrade

soils should be appropriate to achieve the required compaction. Proper drainage of the construction areas should be provided to protect foundation and floor slab subgrade soils from the detrimental effects of weather conditions. Excavations should be kept as dry as possible. Any loose or soft materials that accumulate or develop on subgrade or bearing surfaces should be removed prior to the placement of concrete. Construction traffic, including foot traffic, should be minimized. Concrete should be placed in footing excavations as soon as possible after excavations are completed.

Trucks and other heavy construction vehicles should be restricted as much as possible from trafficking on the finished subgrade in the building to prevent unnecessary disturbances of subgrade soils. Excessive rutting or pumping of the subgrade could occur from construction traffic, particularly during periods of wet weather. If such disturbed areas develop, the subgrade may have to be excavated and replaced with properly compacted fill.

Supplemental engineered fill should be placed in uniform horizontal lifts, with loose thicknesses not exceeding 8 inches. The thickness must be appropriate for the method of compaction and the type of equipment used. The geotechnical engineer should approve any off-site material proposed for use as fill. Engineered fill should be compacted to a minimum of 95 percent of maximum density as determined by ASTM D698 (standard Proctor test) at moisture content between 0 and 4 percent above optimum moisture for high plasticity clay material and from -2 to +2 percent from optimum moisture content for low plasticity clays. Most of the site soils encountered during the exploration are suitable for reuse as engineered fill except below the slab on grade (see Slab on Grade section for more details).

The fill should be benched in any sloped areas greater than one vertical to five horizontal in order to maintain relatively horizontal lifts. The benching should be placed at not less than 12-inch rises over those areas where it is required as the work is brought up in layers.

Lateral Earth Pressures for Retaining Wall Design

The following K values are estimated for the determination of lateral soil resistance for retaining structures and below grade walls based on material characteristics. K_a values are appropriate for calculation of lateral pressure behind retaining walls which are unrestrained at the top and will experience some translational or rotational movement i.e. modular retaining wall. K_o values are appropriate for calculating lateral pressure behind retaining wall that are restrained at the

top and will experience very little or no movement i.e. basement walls. K_p values are used to calculate the lateral pressure exerted by soil experiencing compression during wall movement. These design values do not include the effects of hydrostatic water or surface surcharges.

In Situ High Plasticity Cohesive Soils (Estimated ϕ of 20°)

K_a = 0.49 (active) K_p = 2.04 (passive) K_o = 0.66 (at rest)

Coefficient of sliding friction = 0.30

Wet density of in place soil, average (γ) = 130 pcf

In Situ Low Plasticity Cohesive Soils (Estimated ϕ of 26°)

K_a = 0.39 (active) K_p = 2.56 (passive) K_o = 0.56 (at rest)

Coefficient of sliding friction = 0.33

Wet density of in place soil, average (γ) = 125 pcf

Compacted Low Plasticity Cohesive Soils (Estimated ϕ of 28°)

K_a = 0.36 (active) K_p = 2.77 (passive) K_o = 0.53 (at rest)

Coefficient of sliding friction = 0.35

Wet density of in place soil, average (γ) = 130 pcf

Granular backfill (Estimated ϕ of 35°)

K_a = 0.27 (active) K_p = 3.69 (passive) K_o = 0.42 (at rest)

Coefficient of sliding friction = 0.47

Wet density of in-place gravel, average (γ) = 135 pcf

Shallow Foundations

Shallow foundations bearing on soils would be the recommended foundation type for this project. Although no proposed finish floor elevations were identified and assuming no significant cut/fil operations are intended for these buildings, the native material at the anticipated bearing elevations at a net allowable bearing capacity of 3,000 pounds per square foot (psf) for both continuous footings and rectangular footings.

Anticipated settlements for these bearing capacities are 0.5-0.75 inches of total settlement, with a likely differential settlement of 0.5 inches over a horizontal distance of 30 feet. The minimum

frost depth for this region is 36 inches. We recommend that the minimum column or isolated footing width be 30 inches and the minimum continuous footing width be 18 inches.

Slab on Grade

For slab on grade subgrade, it is recommended that the top 18 inches of subgrade directly below the slab be a low swell potential material or low volume change material (LVC). Acceptable LVC material is any soil type that has a Liquid Limit (LL) less than 45 and a Plasticity Index (PI) less than 25. **The site soil at the proposed building site 1 foot to 3 feet below the existing grade meets the requirement for LVC material and can be used directly below the slab**.

Movement between slabs on grade and walls may occur. To minimize the effects of this movement, we recommend that slip joints be incorporated between all slabs and walls. All slabs should contain crack control and construction joints, which are formed on 15 to 25-foot centers, each way, or as designed by the project structural engineer. A capillary moisture barrier should be placed under the slabs. This barrier should be a minimum of a 6-inch thick layer of clean granular material extending to the limits of the foundation walls. Should additional moisture protection be desired, it should be a minimum of 6-mil polyethylene sheeting placed between the slab and the base course.

For the purpose of slab design, a modulus of subgrade reaction (k) of 100-pounds/cubic inch is suggested. This value is based on a subgrade consisting of well-compacted, plastic clay fill. If a stabilized subgrade is used, a k-value of 200-pounds/cubic inch is suggested.

Surface Drainage

In order to reduce the problems related to water infiltration, it is recommended that the final grade around the structure perimeters have a positive slope extending at least six feet away from the structure. Backfill of soils around the foundation should be compacted at a minimum of 95 percent of maximum dry density at moisture content between optimum and four percent above optimum in accordance with ASTM D 698.

Excavation Considerations

We believe that the project soils are Type B as classified in the OSHA Excavation Standard Handbook 29 CFR Parts 1926.650 through 1926.652. Type B soils are characterized by

cohesive soils above the water table with unconfined compressive strengths greater than 0.5 tons per square foot (tsf) but less than 1.5 tsf. Type B soils include any fill soils meeting the above criteria, as well as undisturbed soils with unconfined compressive strengths of greater than 1.5 tsf which are subject to vibration from traffic. Temporary excavation slopes for Type B soils can be one horizontal to one vertical with a maximum excavation depth of 20 feet.

Excavations deeper than 20 feet may require the use of supplemental shoring and will require the preparation of an excavation design prepared by a registered professional engineer. Competent bedrock material may generally be cut vertically.

Trench Backfill Recommendations

Deleterious materials such as organic matter, topsoil, rock fragments larger than 3 inches in diameter, debris, and any other materials judged to be unsatisfactory by the geotechnical engineer, should not be included in the backfill. Backfill should not be placed on soft materials or frozen ground. Soil backfill overlying the bedding should be placed in uniform horizontal lifts, with loose thicknesses not exceeding 8 inches. The thickness must be appropriate for the method of compaction and the type of equipment used. The geotechnical engineer should approve any off-site material proposed for use as fill. Trench backfill under driveways/parking lots should be compacted to a minimum of 95 percent of maximum density as defined by Standard Proctor (ASTM D 698) at a moisture content between 0 and 4 percent above optimum moisture (preferred average of plus 2 percent). In common yard areas, the soil backfill should be compacted to a minimum of 90 percent of maximum density (ASTM D 698) using the above moisture parameters. After preparation of the trench bottom, a pipe bed of a minimum of 6” shall be prepared using crushed stone or crushed gravel meeting the following requirements:

Nominal Pipe Size Diameter	AASHTO M43 Size
15” or Less	67, 7, 8 or washed #9
Greater than 15”	57, 6, or 67

Manhole/Inlet Structure Backfill Recommendations

Soil backfill around structures should be placed in uniform horizontal lifts, with loose thicknesses not exceeding 8 inches. The thickness must be appropriate for the method of compaction and the type of equipment used. The geotechnical engineer should approve any off-site material proposed for use as fill. Backfill should be compacted to a minimum of 95 percent of maximum

density as defined by Standard Proctor (ASTM D 698) at a moisture content between 0 and 4 percent above optimum moisture (preferred average of plus 2 percent). Another option is to backfill with a Controlled Low Strength Material (CLSM), or flowable fill. The flowable fill should exhibit a minimum unconfined compressive strength of 250 psi after 28 days. Bedding material for manhole/inlet structure should be clean crushed rock conforming to the following gradation:

Sieve Designation	Percent Passing by Weight
1 ½"	100
No. 4	0 – 35
No. 200	0 – 8

PAVEMENT RECOMMENDATIONS

Pavement Subgrade Preparation

Pavement subgrades should be prepared in accordance with the recommendations presented in the SITE PREPARATION and ENGINEERED FILL section of this report. Construction scheduling, involving paving and grading by separate contractors, typically results in a time lapse between the end of grading operations and the commencement of paving. Disturbance, desiccation, and/or wetting of the subgrade between grading and paving can result in deterioration of the previously completed subgrade. A non-uniform subgrade can result in poor pavement performance and local failures soon after pavements are constructed.

If the proposed pavement elevations are close to the existing grade, the site soils at the anticipated pavement subgrade are highly expansive clays (CH). We recommend that the top 12 inches of the subgrade be removed and replaced with crushed limestone such as MODOT Type-5 or KDOT AB-3 placed in 6-inch lifts or stabilize the top 12 inches of the parent soil with 15% flyash, 6% hydrated lime or 5% Portland cement and compacted at 95 percent of maximum dry density per ASTM D698. The CBR value of the treated subgrade is assumed to be in a range of 5 to 8 percent and crushed aggregate CBR value assumed to be in a range of 8 to 12%.

The following options for construction of the roadway, apron, and parking areas are being considered for the project. It is understood that low to moderate levels of truck and airfield traffic may be experienced by the proposed apron and roadway pavements.

Asphaltic Cement Concrete Pavements

Full depth recommended flexible pavement sections are presented in Table 1. The pavement profiles presented below for drive lanes and parking stalls assume only passenger vehicle loading. A heavy-duty pavement section is presented for emergency vehicles and garbage trucks. Passenger vehicles are defined as two-axle, four-wheel vehicles (cars, trucks, vans and SUVs). As indicated, these profiles are considered minimum sections placed on the modified subgrade described earlier.

Table 1

Asphaltic Cement Concrete Pavement on Modified Subgrade (Minimum)

Material	Parking Stalls	Drive Lanes	Heavy Duty
Surface Course	2-inch	2-inch	2-inch
Base Course	4-inch	6-inch	8-inch

The asphaltic base course should be compacted to a minimum of 95 percent of the mixture's Marshall density, when determined in accordance with ASTM D 6926. The surface course should have a minimum Marshall stability of 1800 pounds and be compacted to a minimum of 97 percent of the mixture's Marshall density, when determined in accordance with ASTM D 6926.

Portland Cement Concrete Pavements

Based on the soil types encountered in the proposed apron and roadway areas and previous experience with materials of this type, an effective resilient modulus of 100-pci was estimated for design of ridged pavements on unimproved subgrades. If a stabilized subgrade is used (as recommended), a resilient modulus of 200-pci is suggested.

Portland cement concrete (PCC) pavements are recommended for drive approaches; loading dock aprons, trash dumpster pads and approaches, loading/unloading areas, and other areas where heavy wheel loads will be concentrated. We recommend that the concrete pavements in areas receiving heavy truck traffic have a minimum thickness of 8 inches. If PCC pavements are considered for passenger vehicle areas, we recommend a minimum thickness of 5 inches.

It is also recommended that a 4-inch leveling and drainage course of clean, crushed rock be placed below all PCC pavements and that appropriate sub drainage or connection to a suitable

gravity outfall be provided to remove water from the drainage layer. As an acceptable alternative we recommend the use of Grading "A" Requirements for soil-Aggregate Material listed on ASTM M147 and the grading requirement listed below in lieu of clean rock.

Sieve Designation	Percent Passing by Weight
1"	100
3/8"	30 – 65
No. 4	25 – 65
No. 10	15 – 40
No. 40	8 – 20
No. 200	2 – 8

The PCC mixture should be designed to develop a minimum compressive strength of 4000 psi at 28 days with a 4-inch maximum slump and 5 to 7 percent entrained air. Where Portland cement concrete is used, load transfer devices should be installed at all construction joints or post-placement sawed joints.

Construction Considerations

Construction traffic on the pavements has not been considered in the recommended typical sections. If construction scheduling dictates the pavements will be subject to traffic by construction equipment/vehicles, the pavement thickness should be reconsidered to include the effects of the additional traffic loading. Construction traffic should not be allowed on partially completed pavements as the pavements will not have adequate structural capacity and could be damaged.

Periodic maintenance of all of the pavements should be anticipated. This should include sealing of cracks and joints and by maintaining proper surface drainage to avoid ponding water on or near the pavement areas.

Pavement Drainage

The granular section should be graded to adjacent storm sewer inlets or drainage ditches and provisions should be made to provide drainage from the granular section into the storm sewer. Drainage of the granular base is particularly important where two different sections of

pavements (such as full-depth asphaltic concrete and Portland cement concrete with aggregate base) abut, so that water does not pond beneath the pavements and saturate the subgrade soils.

The performance of pavements will be dependent upon a number of factors, including subgrade conditions at the time of paving, rainwater runoff, and traffic. Rainwater runoff should not be allowed to seep below pavements from adjacent areas. All pavements should be sloped approximately 1/4 inch per foot to provide rapid surface drainage. Proper drainage below the pavement section helps prevent softening of the subgrade and has a significant impact on pavement performance and pavement life. Therefore, we recommend that a granular blanket drain be constructed at all storm sewer inlets within the pavement areas. The blanket drain should consist of clean, crushed stone aggregate extending a minimum of 6 inches below pavement subgrade level. The blanket drains should extend radially a minimum of 8 feet from each of the storm sewer inlets. The grade within the blanket drain should be sloped toward the storm sewer inlet, and weep holes should be drilled through the inlet to provide drainage of the granular section into the inlet. Placement of geotextile filter fabric across the weep holes could be considered to prevent loss of aggregate through the weep holes. These recommendations are very important for long-term performance of the pavements. Because pavements typically have relatively low factors of safety, it will be very important that the specifications are followed closely during pavement construction.

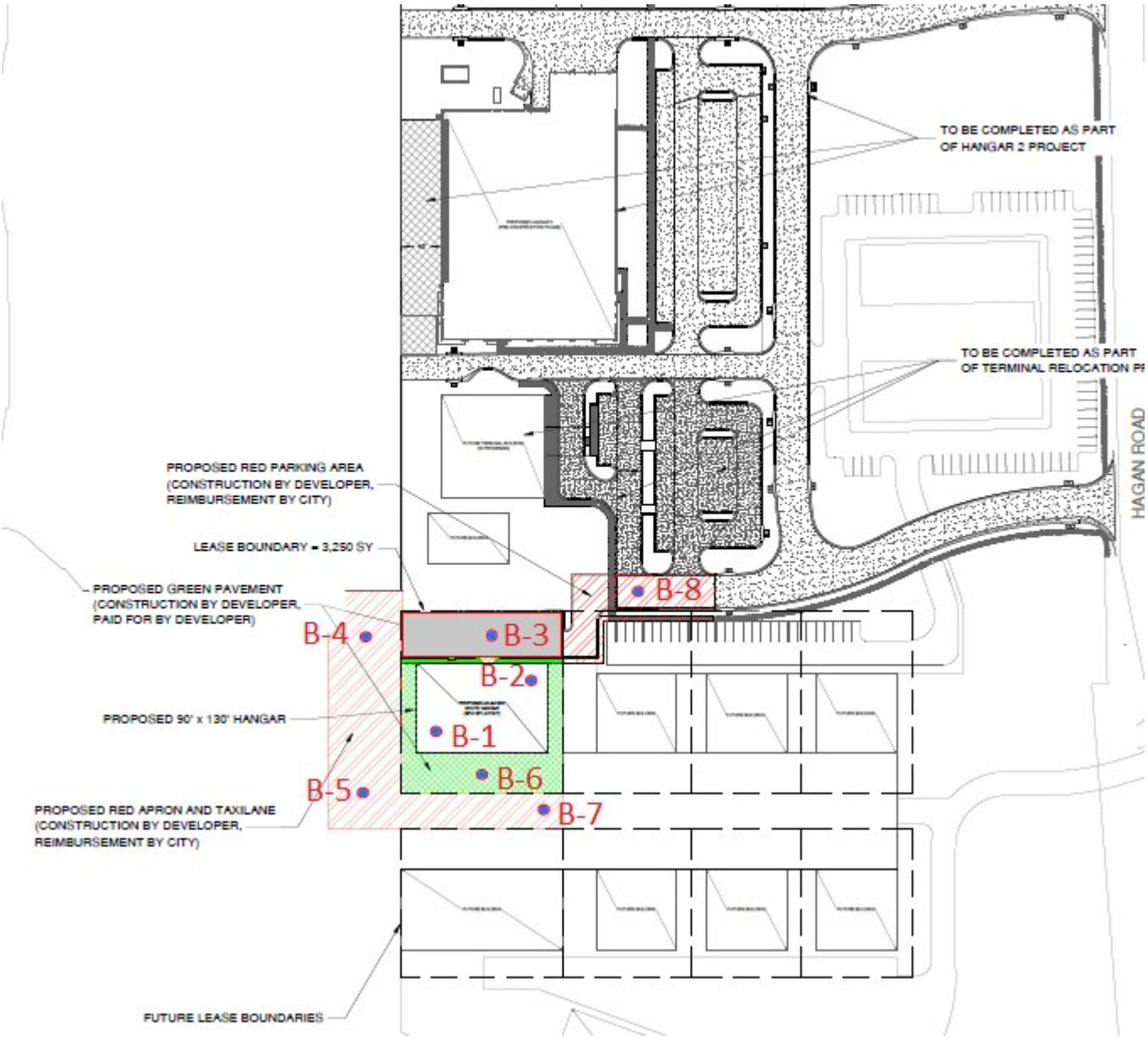
Based on our experience with similar projects, irrigation systems are commonly installed in the landscaped areas adjacent to portions of the pavement areas. If such an irrigation system is to be installed, we recommend that consideration be given to installing subsurface drainage lines between irrigated areas and the planned pavements. It has been our experience that the quantity of subsurface seepage originating from irrigated areas can be substantial and can adversely affect the performance of the pavement subgrade. Therefore, consideration should be given to constructing edge drain lines along the pavements located adjacent to irrigated areas, to intercept and divert subsurface water flows from beneath the pavements. These lines should be constructed behind the curb lines, on the upgradient side of the pavements, and should be sloped to provide positive gravity flow to a suitable outfall.

REMARKS

It is recommended that the geotechnical engineer be retained to review the plans and specifications for the project so that an evaluation and comments can be provided regarding the proper incorporation of information from this geotechnical report into the final construction documents. We further recommend that the geotechnical engineer be retained during construction phases for earthwork and foundations to provide observation and testing to aid in determining that design intent has been accomplished.

The findings in this report are based on data acquired to date and are assumed to be representative of conditions at locations between borings. Due to the fact that the area at the borings is very small relative to the overall site, and for other reasons, we make no statement warranting the conditions below our borings or at other locations throughout the site. In addition, we do not warrant that the general strata logged at the borings are necessarily typical of the remaining areas of the site.

BORING LOCATION DIAGRAM



Boring Location Diagram
Lee's Summit Municipal Airport South Hangar
Lee's Summit, Missouri

KRUGER TECHNOLOGIES, INC.

Drawn: TMA	Date: 9/30/24	Project No: 224158G

APPENDIX I

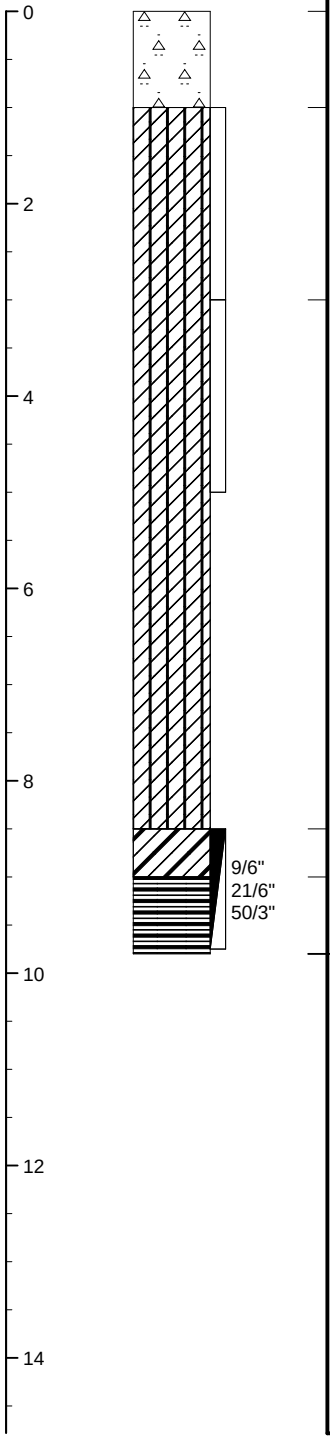
Boring Logs

LOG OF TEST BORING

BORING B-1

PROJECT: Lee's Summit Municipal Airport South Hangar
CLIENT: Wellner Architects
PROJECT NO.: 224158G **START:** 9/8/24
BORING LOCATION: See Boring Location Plan
METHOD OF DRILLING: 4" Continuous Flight Augers
DEPTH TO - water None **caving**

DATE: 10/1/2024
ELEVATION:
FINISH: 9/8/24
LOGGER: Hunter
DATE CHECKED:



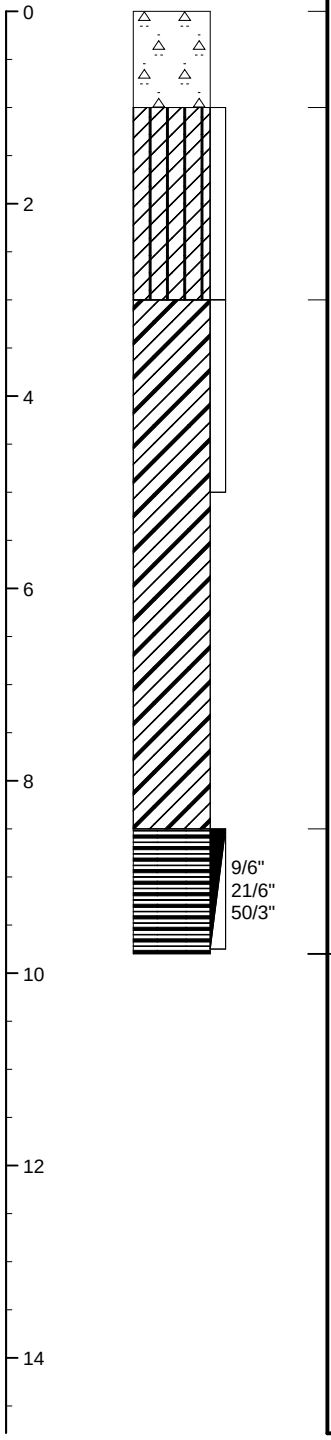
ELEVATION/ DEPTH	USCS	Description	Sample # & Type	Density pcf	Moist-ure, %	Qu, psf
	T	**Topsoil**				
	CL	**Lean clay, stiff, dark brown, moist**	1, ST	110.3	18.8	
	CL	**Lean clay, very stiff, grayish brown, moist**	2, ST	107.3	16.9	9883
	CL-CH	**Lean to fat clay , stiff, grayish brown, moist**	1, SS		15.4	
	W	**Weathered shale, very stiff, gray**				
		Drilling discontinued at sample refusal at 9.8 feet				

Notes:

LOG OF TEST BORING
BORING B-2

PROJECT: Lee's Summit Municipal Airport South Hangar
CLIENT: Wellner Architects
PROJECT NO.: 224158G **START:** 9/8/24
BORING LOCATION: See Boring Location Plan
METHOD OF DRILLING: 4" Continuous Flight Augers
DEPTH TO - water None **caving**

DATE: 10/1/2024
ELEVATION:
FINISH: 9/8/24
LOGGER: Hunter
DATE CHECKED:



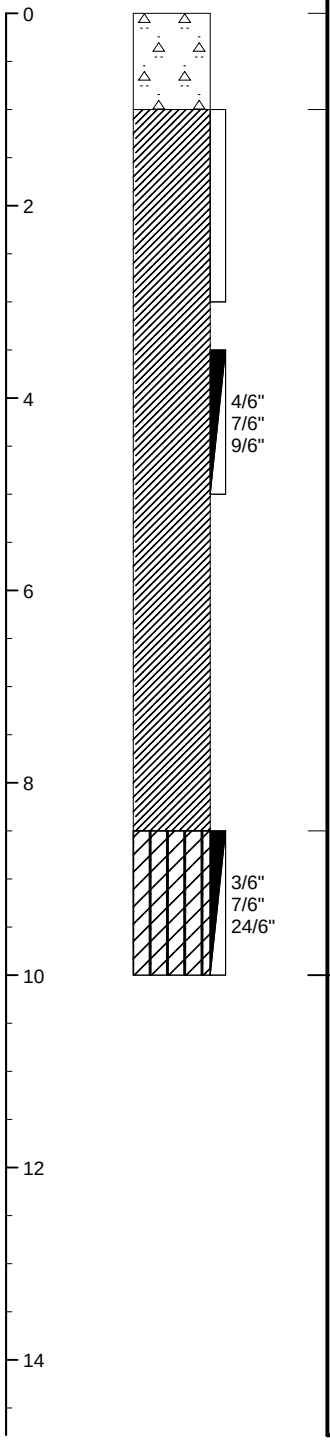
ELEVATION/ DEPTH	USCS	Description	Sample # & Type	Density pcf	Moist-ure, %	Qu, psf
	T	**Topsoil**				
	CL	**Lean clay, stiff, orange brown, moist**	1, ST	102.9	18.6	
	CL-CH	**Lean to fat clay, some weathered shale, very stiff, dark grayish brown, moist**	2, ST	110.9	14.9	10523
	W	**Weathered shale, very stiff, gray, moist**	1, SS		21.8	
		Drilling discontinued at sample refusal at 9.8 feet				

Notes:

LOG OF TEST BORING
BORING B-3

PROJECT: Lee's Summit Municipal Airport South Hangar
CLIENT: Wellner Architects
PROJECT NO.: 224158G **START:** 9/8/24
BORING LOCATION: See Boring Location Plan
METHOD OF DRILLING: 4" Continuous Flight Augers
DEPTH TO - water None **caving**

DATE: 10/1/2024
ELEVATION:
FINISH: 9/8/24
LOGGER: Hunter
DATE CHECKED:



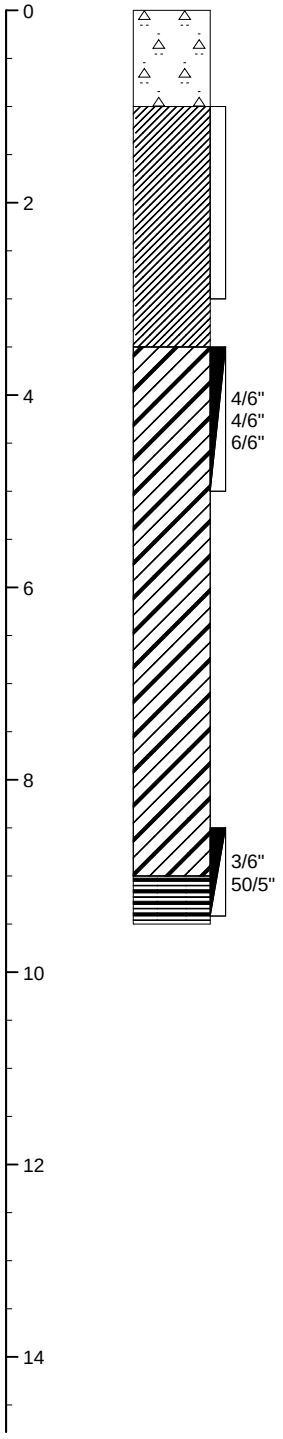
ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist-ure, %	Qu, psf
		T	**Topsoil**				
			Fat clay, stiff, grayish brown, moist	1, ST	100.9	17.4	6411
		CH	**Lean to fat clay, stiff, dark reddish brown, moist**	1, SS		17.4	
		CL	**Lean clay, trace weathered shale, very stiff, dark brown, moist**	1, SS		14.8	
			Drilling discontinued at 10.0 feet				

Notes:

LOG OF TEST BORING
BORING B-4

PROJECT: Lee's Summit Municipal Airport South Hangar
CLIENT: Wellner Architects
PROJECT NO.: 224158G **START:** 9/8/24
BORING LOCATION: See Boring Location Plan
METHOD OF DRILLING: 4" Continuous Flight Augers
DEPTH TO - water None **caving**

DATE: 10/1/2024
ELEVATION:
FINISH: 9/8/24
LOGGER: Hunter
DATE CHECKED:



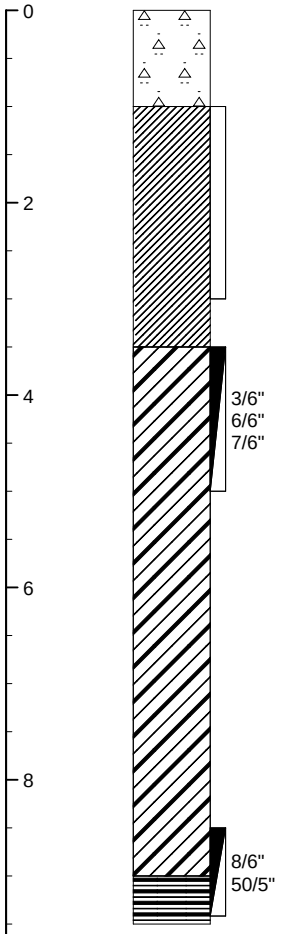
ELEVATION/ DEPTH	USCS	Description	Sample # & Type	Density pcf	Moist-ure, %	Qu, psf
	T	**Topsoil**				
	CH	**Fat clay, stiff, dark reddish brown, moist**	1, ST	107.6	19.2	
	CL-CH	**Lean to fat clay, stiff, reddish brown, moist**	1, SS		15.7	
	CL-CH	**Lean to fat clay, stiff, reddish brown, moist**	1, SS		11.4	
	W	**Weathered shale, hard, gray**				
		Drilling discontinued at sample refusal 9.5 feet				

Notes:

LOG OF TEST BORING
BORING B-5

PROJECT: Lee's Summit Municipal Airport South Hangar
CLIENT: Wellner Architects
PROJECT NO.: 224158G **START:** 9/8/24
BORING LOCATION: See Boring Location Plan
METHOD OF DRILLING: 4" Continuous Flight Augers
DEPTH TO - water None **caving**

DATE: 10/1/2024
ELEVATION:
FINISH: 9/8/24
LOGGER: Hunter
DATE CHECKED:



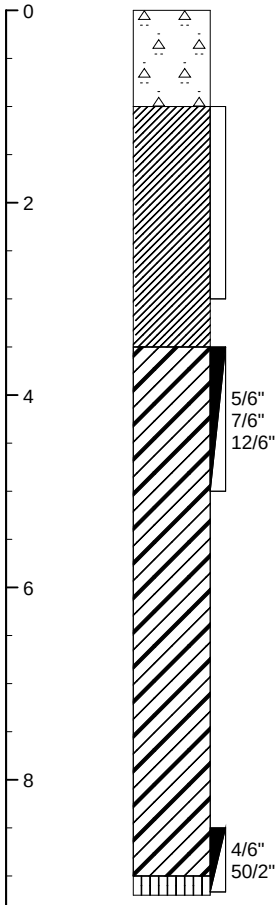
ELEVATION/ DEPTH	USCS	Description	Sample # & Type	Density pcf	Moist-ure, %	Qu, psf
	T	**Topsoil**				
	CH	**Fat clay with weathered sandstone, very stiff, reddish brown, moist**	1, ST	110.3	16.3	14890
	CL-CH	**Lean to fat clay, stiff, dark reddish brown, moist**	1, SS		22.3	
	W	**Lean to fat clay, stiff, reddish brown, moist to dry**	1, SS		8.5	
		Weathered shale, hard, gray				
		Drilling discontinued at sample refusal 9.5 feet				

Notes:

LOG OF TEST BORING
BORING B-6

PROJECT: Lee's Summit Municipal Airport South Hangar
CLIENT: Wellner Architects
PROJECT NO.: 224158G **START:** 9/8/24
BORING LOCATION: See Boring Location Plan
METHOD OF DRILLING: 4" Continuous Flight Augers
DEPTH TO - water None **caving**

DATE: 10/1/2024
ELEVATION:
FINISH: 9/8/24
LOGGER: Hunter
DATE CHECKED:



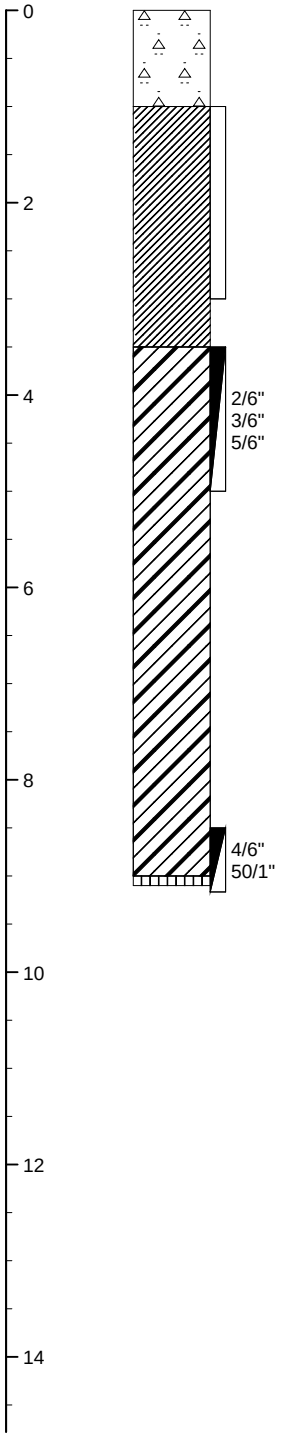
ELEVATION/ DEPTH	USCS	Description	Sample # & Type	Density pcf	Moist-ure, %	Qu, psf
	T	**Topsoil**				
	CH	**Fat clay, stiff, dark grayish brown, moist**	1, ST		14.5	
	CL-CH	**Lean to fat clay, stiff to very, dark orange brown, moist**	1, SS		18.0	
	S	**Lean to fat clay, stiff, reddish brown, moist** **Shale, weathered, hard, gray**	1, SS		16.2	
		Drilling discontinued at sample refusal 9.2 feet				

Notes:

LOG OF TEST BORING
BORING B-7

PROJECT: Lee's Summit Municipal Airport South Hangar
CLIENT: Wellner Architects
PROJECT NO.: 224158G **START:** 9/8/24
BORING LOCATION: See Boring Location Plan
METHOD OF DRILLING: 4" Continuous Flight Augers
DEPTH TO - water None **caving**

DATE: 10/1/2024
ELEVATION:
FINISH: 9/8/24
LOGGER: Hunter
DATE CHECKED:



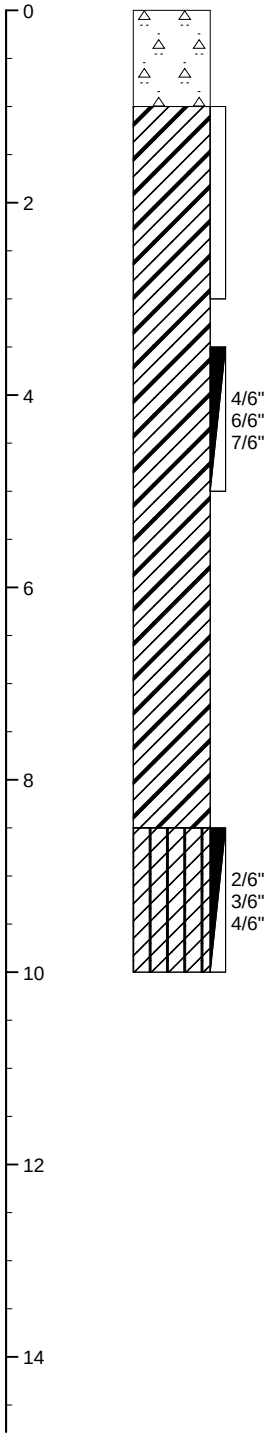
ELEVATION/ DEPTH	USCS	Description	Sample # & Type	Density pcf	Moist-ure, %	Qu, psf
	T	**Topsoil**				
	CH	**Fat clay, some gravel, stiff, light brown, moist**	1, ST	107.2	16.5	14060
		Lean to fat clay, stiff, reddish brown, moist	1, SS		20.0	
	CL-CH					
	CL-CH	**Lean to fat clay, stiff, orange brown, moist**	1, SS		22.1	
	S	**Shale, hard, gray**				
		Drilling discontinued at sample refusal 9.1 feet				

Notes:

LOG OF TEST BORING
BORING B-8

PROJECT: Lee's Summit Municipal Airport South Hangar
CLIENT: Wellner Architects
PROJECT NO.: 224158G **START:** 9/8/24
BORING LOCATION: See Boring Location Plan
METHOD OF DRILLING: 4" Continuous Flight Augers
DEPTH TO - water None **caving**

DATE: 10/1/2024
ELEVATION:
FINISH: 9/8/24
LOGGER: Hunter
DATE CHECKED:



ELEVATION/ DEPTH	USCS	Description	Sample # & Type	Density pcf	Moist-ure, %	Qu, psf
	T	**Topsoil**				
	CL-CH	**Lean to fat clay, very stiff, orange brown, moist**	1, ST	113.3	14.4	11471
	CL-CH	**Lean to fat clay, stiff, dark reddish brown, moist**	1, SS		17.0	
	CL	**Lean clay, medium stiff, reddish brown, moist**	1, SS		19.9	
		Drilling discontinued at 10.0 feet				

Notes:

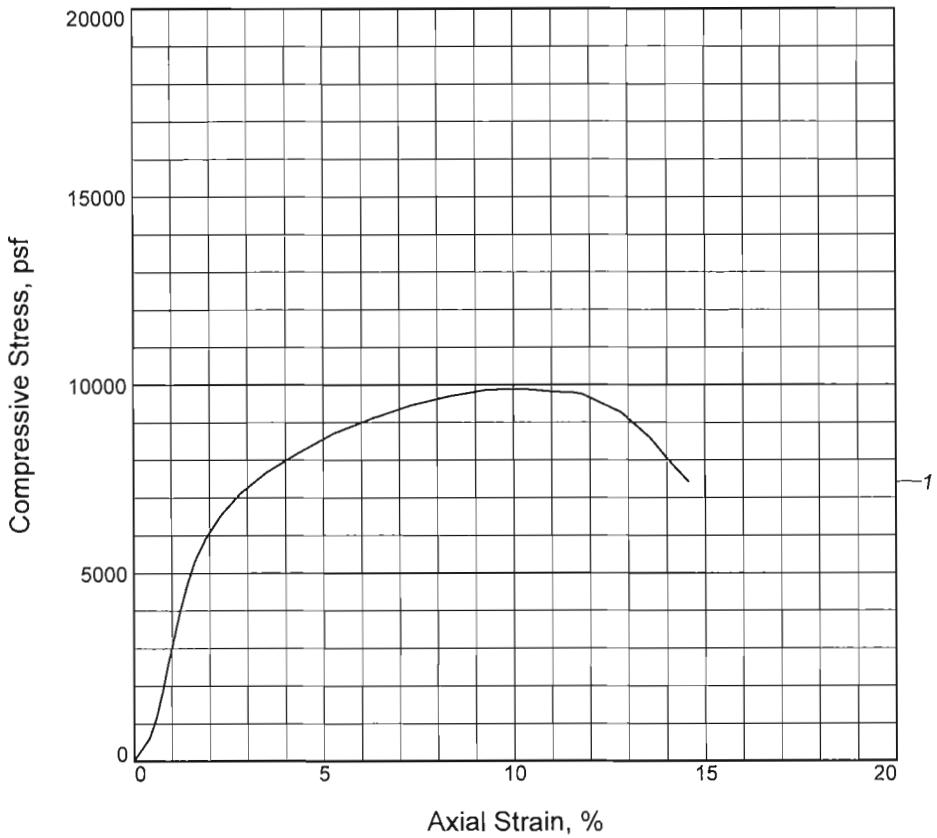
APPENDIX II

Laboratory Results

SUMMARY OF LABORATORY TEST RESULTS UNDISTURBED SAMPLE

Boring	Depth (Ft)	Sample No./Type	Natural Moisture %	Natural Dry Density (pcf)	Unconfined Compressive Strength (psf)	Atterberg Limits		Soil Type
						Liquid Limit %	Plasticity Index %	
B-1	1.0-3.0	ST-1	18.8	110.3		43	22	CL
B-1	3.0-5.0	ST-2	16.9	107.3	9883			
B-2	8.5-10.0	SS-1	15.4					
B-2	1.0-3.0	ST-1	18.6	102.9		46	25	CL
B-2	3.0-5.0	ST-2	14.9	110.9	10523			
B-2	8.5-10.0	SS-1	21.8					
B-3	1.0-3.0	ST-1	17.4	100.9	6411	59	35	CH
B-3	3.5-5.0	SS-1	17.4					
B-3	8.5-10.0	SS-2	14.8					
B-4	1.0-3.0	ST-1	19.2	107.6				
B-4	3.5-5.0	SS-1	15.7					
B-4	8.5-10.0	SS-2	11.4					
B-5	1.0-3.0	ST-1	16.3	110.3	14890	59	36	CH
B-5	3.5-5.0	SS-1	22.3					
B-5	8.5-10.0	SS-2	8.5					
B-6	1.0-3.0	ST-1	14.5			57	33	CH
B-6	3.5-5.0	SS-1	18.0					
B-6	8.5-10.0	SS-2	16.2					
B-7	1.0-3.0	ST-1	16.5	107.2	14060	60	34	CH
B-7	3.5-5.0	SS-1	20.0					
B-7	8.5-10.0	SS-2	22.1					
B-8	1.0-3.0	ST-1	14.4	113.3	11471			
B-8	3.5-5.0	SS-1	17.0					
B-8	8.5-10.0	SS-2	19.9					

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	9883			
Undrained shear strength, psf	4942			
Failure strain, %	10.3			
Strain rate, in./min.	1.000			
Water content, %	16.9			
Wet density, pcf	125.4			
Dry density, pcf	107.3			
Saturation, %	78.8			
Void ratio	0.5831			
Specimen diameter, in.	2.77			
Specimen height, in.	5.60			
Height/diameter ratio	2.02			

Description: Lean clay, very stiff, grayish brown, moist

LL =	**PL =**	**PI =**	**Assumed GS=** 2.72	**Type:** ST

Project No.: 224158G
Date Sampled: 9/8/24
Remarks:

Client: Wellner Architects

Project: Lee's Summit Municipal Airport South Hangar

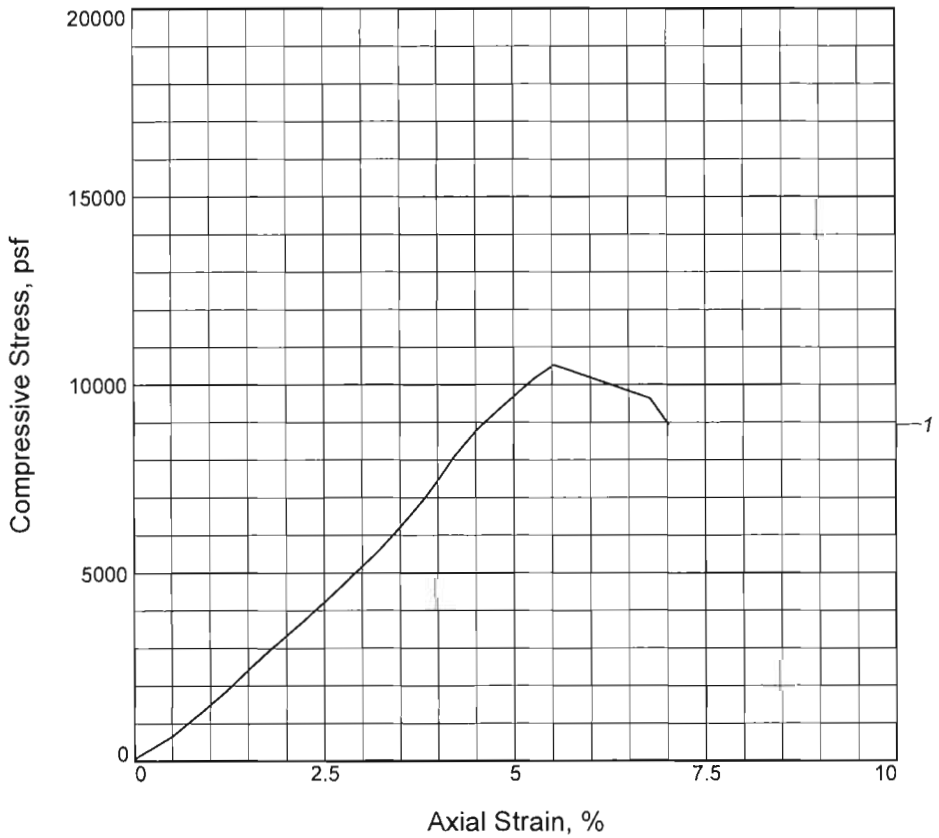
Source of Sample: B-1 **Depth:** 3
Sample Number: 2

Figure _____

[redacted]KTI[redacted]

Tested By: TA _____ **Checked By:** OJK _____

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	10523			
Undrained shear strength, psf	5262			
Failure strain, %	5.5			
Strain rate, in./min.	0.050			
Water content, %	14.9			
Wet density, pcf	127.4			
Dry density, pcf	110.9			
Saturation, %	76.4			
Void ratio	0.5316			
Specimen diameter, in.	2.84			
Specimen height, in.	5.62			
Height/diameter ratio	1.98			

Description: Lean to fat clay, some weathered shale, very stiff, dark grayish brown, moist

LL =	PL =	PI =	Assumed GS= 2.72	Type: ST

Project No.: 224158G
Date Sampled: 9/8/24
Remarks:

Client: Wellner Architects

Project: Lee's Summit Municipal Airport South Hangar

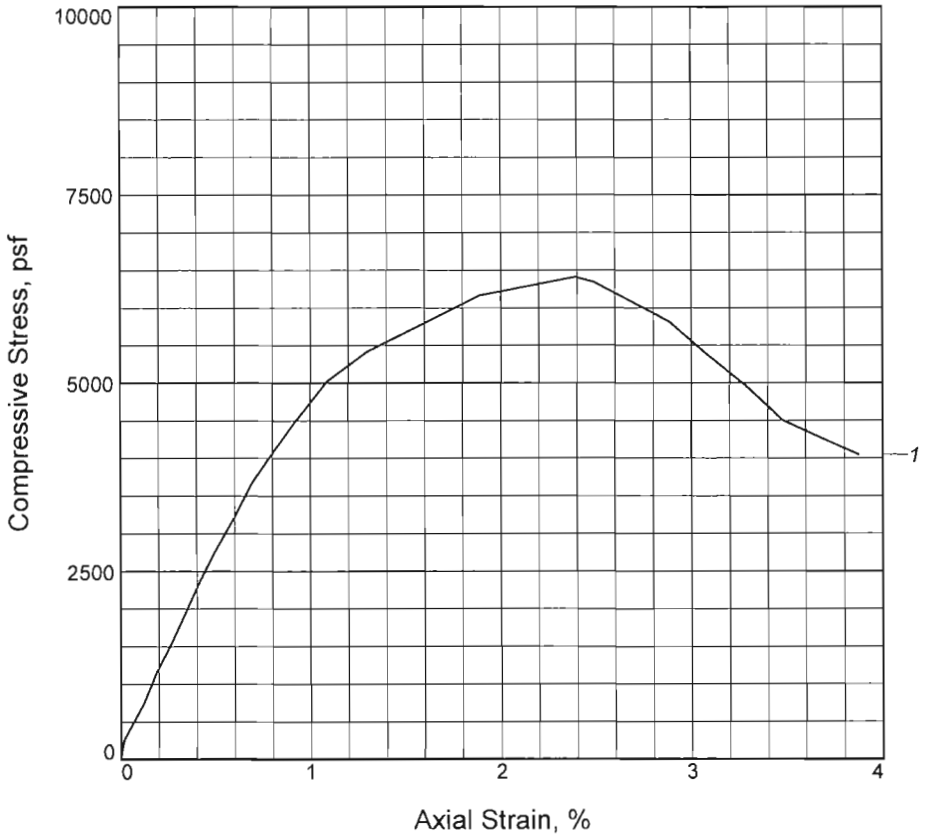
Source of Sample: B-2 **Depth:** 3
Sample Number: 2

[redacted]KTI[redacted]

Figure _____

Tested By: TA **Checked By:** OJK

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	6411			
Undrained shear strength, psf	3205			
Failure strain, %	2.4			
Strain rate, in./min.	0.050			
Water content, %	17.4			
Wet density, pcf	118.5			
Dry density, pcf	100.9			
Saturation, %	69.5			
Void ratio	0.6825			
Specimen diameter, in.	2.88			
Specimen height, in.	5.67			
Height/diameter ratio	1.97			

Description: Fat clay, stiff, grayish brown, moist

LL = 59	**PL =** 24	**PI =** 35	**Assumed GS=** 2.72	**Type:** ST

Project No.: 224158G
Date Sampled: 9/8/24
Remarks:

Client: Wellner Architects

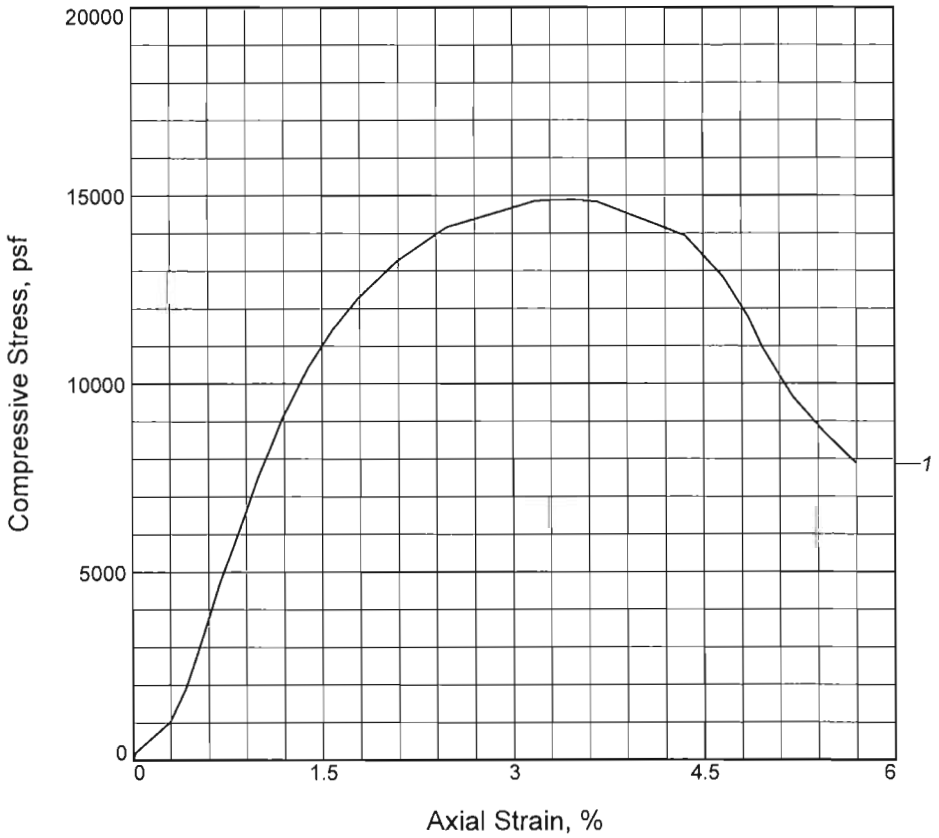
Project: Lee's Summit Municipal Airport South Hangar

Source of Sample: B-3 **Depth:** 1
Sample Number: 1

Figure _____

Tested By: TA _____ **Checked By:** OJK _____

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	14890			
Undrained shear strength, psf	7445			
Failure strain, %	3.5			
Strain rate, in./min.	0.050			
Water content, %	16.3			
Wet density, pcf	128.4			
Dry density, pcf	110.3			
Saturation, %	82.5			
Void ratio	0.5391			
Specimen diameter, in.	2.85			
Specimen height, in.	5.68			
Height/diameter ratio	1.99			

Description: Fat clay with weathered sandstone, very stiff, reddish brown, moist

LL = 59	**PL =** 23	**PI =** 36	**Assumed GS=** 2.72	**Type:** ST

Project No.: 224158G
Date Sampled: 9/8/24
Remarks:

Client: Wellner Architects

Project: Lee's Summit Municipal Airport South Hangar

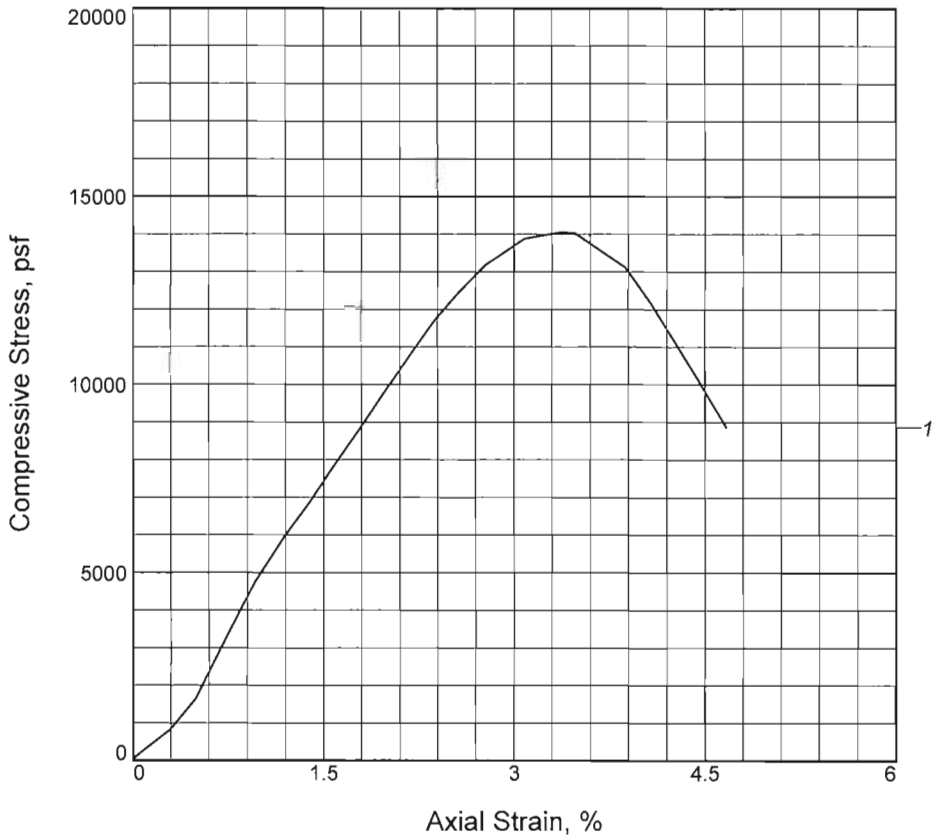
Source of Sample: B-5 **Depth:** 1
Sample Number: 1

Figure _____

[redacted]KTI[redacted]

Tested By: TA _____ **Checked By:** OJK _____

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	14060			
Undrained shear strength, psf	7030			
Failure strain, %	3.4			
Strain rate, in./min.	0.050			
Water content, %	16.5			
Wet density, pcf	124.8			
Dry density, pcf	107.2			
Saturation, %	76.7			
Void ratio	0.5843			
Specimen diameter, in.	2.84			
Specimen height, in.	5.67			
Height/diameter ratio	2.00			

Description: Fat clay, some gravel, very stiff, light brown, moist

LL = 60	**PL =** 26	**PI =** 34	**Assumed GS=** 2.72	**Type:** ST

Project No.: 224158G
Date Sampled: 9/8/24
Remarks:

Client: Wellner Architects

Project: Lee's Summit Municipal Airport South Hangar

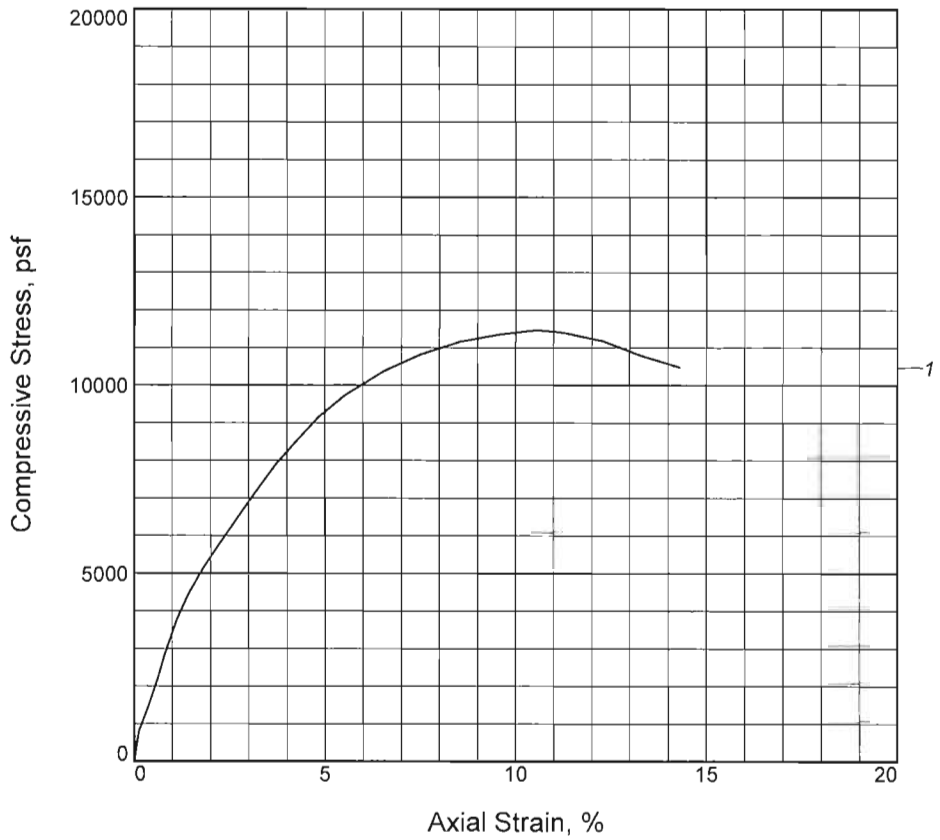
Source of Sample: B-7 **Depth:** 1
Sample Number: 1

[redacted]KTI[redacted]

Figure _____

Tested By: TA **Checked By:** OJK

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	11471			
Undrained shear strength, psf	5736			
Failure strain, %	10.5			
Strain rate, in./min.	0.050			
Water content, %	14.4			
Wet density, pcf	129.9			
Dry density, pcf	113.5			
Saturation, %	79.2			
Void ratio	0.4957			
Specimen diameter, in.	2.81			
Specimen height, in.	5.61			
Height/diameter ratio	2.00			

Description: Lean to fat clay, some gravel, very stiff, orange brown, moist

LL =	PL =	PI =	Assumed GS= 2.72	Type: ST

Project No.: 224158G
Date Sampled: 9/8/24
Remarks:

Client: Wellner Architects

Project: Lee's Summit Municipal Airport South Hangar

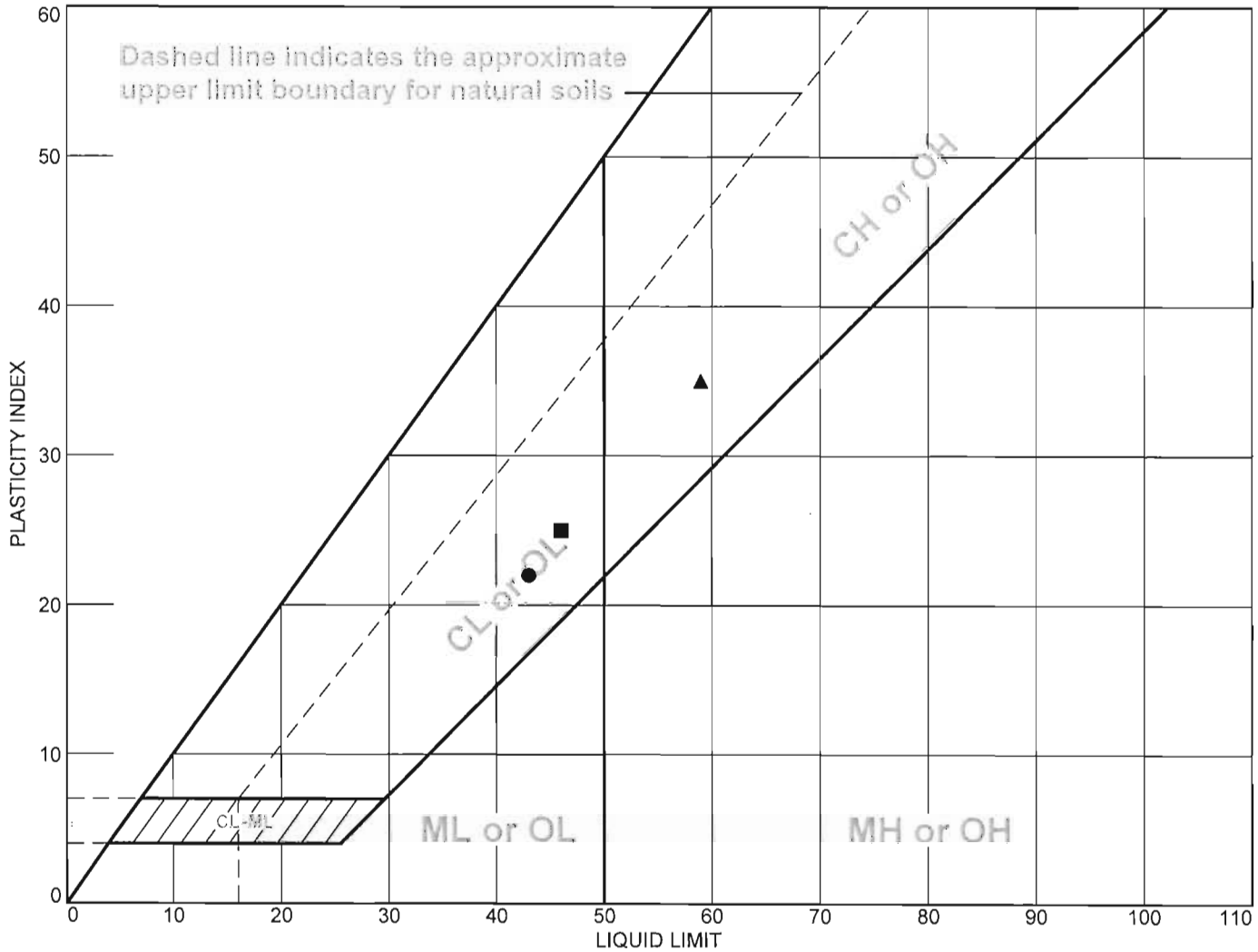
Source of Sample: B-8 **Depth:** 1
Sample Number: 1

[redacted]KTI[redacted]

Figure _____

Tested By: TA **Checked By:** OJK

LIQUID AND PLASTIC LIMITS TEST REPORT ASTM D 4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Lean clay, stiff, dark brown, moist	43	21	22			CL
■	Lean clay, stiff, orange brown, moist	46	21	25			CL
▲	Fat clay, stiff, grayish brown, moist	59	24	35			CH

Project No. 224158G **Client:** Wellner Architects

Project: Lee's Summit Municipal Airport South Hangar

● **Source of Sample:** B-1 **Depth:** 1 **Sample Number:** 1

■ **Source of Sample:** B-2 **Depth:** 1 **Sample Number:** 1

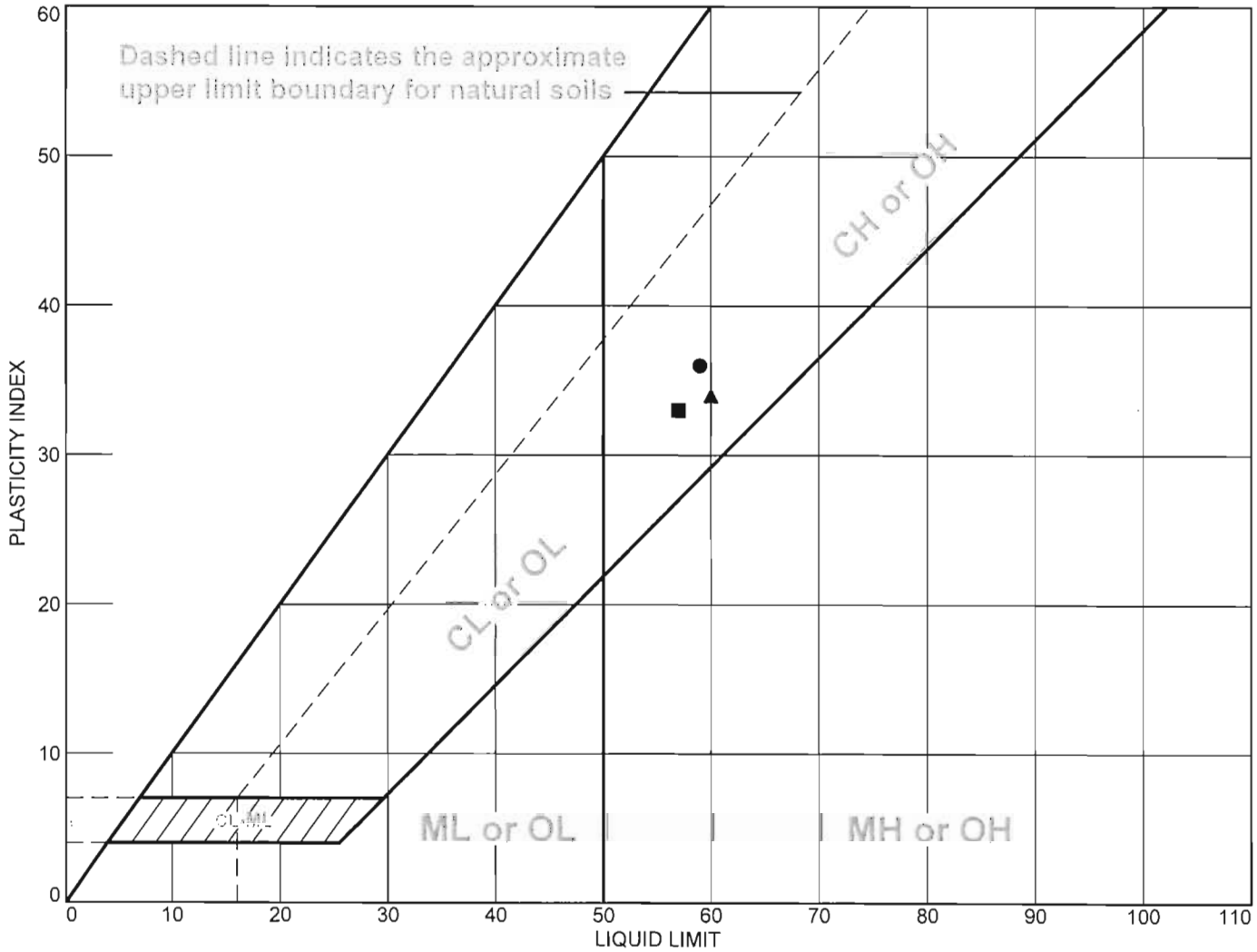
▲ **Source of Sample:** B-3 **Depth:** 1 **Sample Number:** 1

Remarks:

KTI

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT ASTM D 4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Fat clay with weathered sandstone, very stiff, reddish brown, moist	59	23	36			CH
■	Fat clay, stiff, dark grayish brown, moist	57	24	33			CH
▲	Fat clay, some gravel, very stiff, light brown, moist	60	26	34			CH

Project No. 224158G **Client:** Wellner Architects

Project: Lee's Summit Municipal Airport South Hangar

● **Source of Sample:** B-5 **Depth:** 1 **Sample Number:** 1

■ **Source of Sample:** B-6 **Depth:** 1 **Sample Number:** 1

▲ **Source of Sample:** B-7 **Depth:** 1 **Sample Number:** 1

Remarks:

[redacted]KTI[redacted]

Figure

GLOSSARY OF GEOTECHNICAL TERMS

ALLUVIUM	Sediments deposited by streams, including riverbeds and floodplains.
ARGILLACEOUS	Rocks composed of or having a notable portion of fine silt and/or clay in their composition.
ATTERBERG LIMITS	Water contents, in percentage of dry weight of soil, that correspond to the boundaries between the states of consistency, i.e. the boundary between the liquid and plastic states (liquid limit) and the boundary between the plastic and solid states (plastic limit).
BEDROCK-IN-PLACE	Continuous rock mass which essentially has not moved from its original depositional position.
CALCAREOUS	Containing calcium carbonate determined by effervescence when tested with dilute hydrochloric acid.
CHANNEL SANDSTONE	Sandstone that has been deposited in a streambed or other channel eroded into the underlying beds.
COLLUVIAL	Rock debris of various sizes loose from in-place bedrock mass, often shifted down gradient in conjunction with soil.
CROSS-BEDDING	Stratification which is inclined to the original horizontal surface upon which the sediment accumulated.
FISSILE BEDDING	Term applied to bedding which consists of laminae less than 2 millimeters in thickness.
FORMATION	A distinctive body of rock that serves as a convenient unit for study and mapping.
FOSSIL DETRITUS	The accumulation of broken, fragmented fossil debris.
FOSSILIFEROUS	Containing organic remains.
GLACIAL ERRATIC	A transported rock fragment different from the bedrock on which it lies, either free or as part of a sediment.
GLACIAL TILL	Nonsorted, nonstratified sediment carried or deposited by a glacier.
GLACIOFLUVIAL	Primarily deposited by streams from glaciers.
GROUP	A lithostratigraphic unit consisting of two or more formations.

JOINT	A fracture in a rock along which no appreciable displacement has occurred.
LIMESTONE	A sedimentary rock composed mostly of calcium carbonate ($CaCO_3$).
LOESS	A homogenous, nonstratified, unindurated deposit consisting predominantly of silt, with subordinate amounts of very fine sand and/or clay.
MICA	A mineral group, consisting of phyllosilicates, with sheetlike structures.
MEMBER	A specially developed part of a varied formation is called a member, if it has considerable geographic extent.
NODULE	A small, irregular, knobby, or rounded rock that is generally harder than the surrounding rock.
PERMEABILITY	The capacity of a material to transmit a fluid.
RECOVERY	The percentage of bedrock core recovered from a core run length.
RELIEF	The difference in elevation between the high and low points of a land surface.
RESIDUAL SOIL	Soil formed in place by the disintegration and decomposition of rocks and the consequent weathering of the mineral materials.
ROCK QUALITY DESIGNATION (RQD)	Refers to percentage of core sample recovered in unbroken lengths of 4 inches or more.
SANDSTONE	Sedimentary rock composed mostly of sand sized particles, usually cemented by calcite, silica, or iron oxide.
SERIES	A time-stratigraphic unit ranked next below a system.
SHALE	A fine-grained plastic sedimentary rock formed by consolidation of clay and mud.
STRATIGRAPHY	Branch of geology that treats the formation, compositions, sequence, and correlation of the stratified rocks as parts of the earth's crust.
SYSTEM	Designates rocks formed during a fundamental chronological unit, a period.
UNCONFORMITY	A surface of erosion or nondeposition, usually the former, which separates younger strata from older rocks.
WEATHERING	The physical and chemical disintegration and decomposition of rocks and minerals.

General Notes

Laboratory Test Symbols	
Symbol	**Definition**
LL	Liquid Limit (ASTM D4318)
PL	Plastic Limit (ASTM D4318)
PI	Plasticity Index (LL minus PL)
Qu	Unconfined Compressive Strength, Pounds per Square Foot (psf)
Qp	Pocket Penetrometer Reading, Tons per Square Foot (TSF)
RQD	Rock Quality Designation % (Sum of rock core pieces >4 inches/length of core run)

Common Soil Classification Symbols

Clay	
Symbol	**Soil Type**
CL	Low plasticity clay
CL-ML	Low plasticity clay and silt
CL/CH	Medium plasticity clay
CH	High plasticity clay

Silt	
Symbol	**Soil Type**
ML	Low plasticity silt
MH	High plasticity silt

Sand	
Symbol	**Soil Type**
SW	Well graded sand
SP	Poorly graded sand
SM	Silty sand
SC	Clayey sand

Gravel	
Symbol	**Soil Type**
GW	Well graded gravel
GP	Poorly graded gravel
GM	Silty gravel
GC	Clayey gravel

Descriptive Terminology

Cohesionless Soils

Relative Density Term	"N" Value
Very Loose	0 - 4
Loose	5 - 9
Medium Dense	10 - 29
Dense	30 – 49
Very Dense	50 or more

Cohesive Soils

Consistency Term	"N" Value
Very soft	0 – 2
Soft	3 – 4
Medium	5 – 8
Stiff	9 – 15
Very Stiff	16 - 30
Hard	> 30

Relative Proportions and Sizes

Term	Range
Trace	< 5%
A Little	5 – 15%
Some	15 – 30%
With	30 – 50%

Material	Size
Boulder	> 12"
Cobble	3" – 12"
Gravel	4.75 - 76.2 mm
Sand	0.075 – 4.75 mm
Silt and Clay	< 0.075 mm

DOCUMENT 004113 - BID FORM - STIPULATED SUM (SINGLE-PRIME CONTRACT)

PART 1 - GENERAL

1.1 BID INFORMATION

A. Bidder: _____.

B. Project Name: TM Aviation Hangar at LXT.

C. Project Location: Lee's Summit, MO.

D. Owner: TM Aviation.

E. Architect: Wellner Architects + Engineers.

F. Architect Project Number: 2404.

1.2 CERTIFICATIONS AND BASE BID

A. Base Bid, Single-Prime (All Trades) Contract: The undersigned Bidder, having carefully examined the Procurement and Contracting Requirements, Conditions of the Contract, Drawings, Specifications, and all subsequent Addenda, as prepared by Wellner Architects + Engineers and Architect's consultants, having visited the site, and being familiar with all conditions and requirements of the Work, hereby agrees to furnish all material, labor, equipment and services necessary to complete the construction of the above-named Project, in accordance with the requirements of the Procurement and Contracting Documents:

1. The stipulated sum for the private scope:

   _____ Dollars ($_____).

2. The stipulated sum for the public scope:

   _____ Dollars ($_____).

3. The total of the above items 1 and 2, (the Work):

   _____ Dollars ($_____).

4. The above amount may be modified by amounts indicated by the Bidder under the "Unit Prices" Article below.

1.3 UNIT PRICES

A. The undersigned Bidder proposes the amounts below be added to or deducted from the Contract Sum on performance and measurement of the individual items of the Work, as described in Section 012200 "Unit Prices".

B. If the Unit Price does not affect the Work of this Contract, the Bidder to indicate "NOT APPLICABLE."

~~C. Unit-Price No. 1: Removal of unsatisfactory soil and replacement with satisfactory soil material.~~

1. _____ ~~dollars ($_____) per~~ unit.

~~D. Unit-Price No. 2: Rock excavation and replacement with satisfactory soil material.~~

1. _____ ~~dollars ($_____) per~~ unit.

E. Unit-Price No. 3: Miscellaneous steel rebar.

1. _____ dollars ($_____) per unit.

F. Unit-Price No. 4: Miscellaneous and structural steel.

1. _____ dollars ($_____) per unit.

G. Unit-Price No. 5: Miscellaneous concrete foundations.

1. _____ dollars ($_____) per unit.

1.4 BID SECURITY

A. The undersigned Bidder agrees to execute a contract for this Work in the above amount and to furnish surety as specified within 10 days after a written Notice of Award, if offered within 60 days after receipt of bids, and on failure to do so agrees to forfeit to Owner the attached Bid Security, as liquidated damages for such failure as follows:

1. In the following amount constituting 5 percent of the Base Bid amount above:

a. _____ Dollars ($_____).

B. Form of Bid Security: Bidder has attached the following:

1. ▢ AIA Document A310-2010, "Bid Bond."
2. ▢ Cashier's check.

3. ▢ Certified check.

C. In the event Owner does not offer Notice of Award within the time limits stated above, Owner will return to the undersigned the cashier's check, certified check, or bid bond.

1.5 SUBCONTRACTORS AND SUPPLIERS

A. The following companies to execute subcontracts for the portions of the Work indicated:

1. Concrete Work:

_____.

2. PEMB Work:

_____.

3. Plumbing Work:

_____.

4. HVAC Work:

_____.

5. Electrical Work:

_____.

6. Excavation/Site Work:

_____.

1.6 TIME OF COMPLETION

A. Time of Completion:

1. The undersigned Bidder proposes and agrees hereby to commence the Work of the Contract Documents on a date specified in a written Notice to Proceed to be issued by Architect, and to substantially complete the Work within 340 calendar days.

1.7 ACKNOWLEDGMENT OF ADDENDA

A. The undersigned Bidder acknowledges receipt of and use of the following Addenda in

the preparation of this Bid:

1. Addendum No. 1, dated _____.
2. Addendum No. 2, dated _____.
3. Addendum No. 3, dated _____.
4. Addendum No. 4, dated _____.

1.8 CONTRACTOR'S LICENSE

A. The undersigned further states that it is a duly licensed contractor, for the type of work proposed, in Lee's Summit, MO, and that all fees, permits, etc., pursuant to submitting this proposal have been paid in full.

1.9 SUBMISSION OF BID

A. Respectfully submitted this ____ day of _____ 2025.

B. Submitted by: _____ (Name of bidding firm or corporation).

C. Authorized Signature: _____ (Handwritten signature).

D. Signed by: _____(Type or print name).

E. Title: _____ (Owner/Partner/President/Vice President).

F. Witnessed by: _____ (Handwritten signature).

G. Attest: _____ (Handwritten signature).

H. By: _____ (Type or print name).

I. Attester Title: _____ (Corporate Secretary or Assistant Secretary).

J. Street Address:
_____.

K. City, State, Zip: _____.

L. Phone: _____.

M. License No.:_____.

N. Federal ID No.: _____.

O. (Affix Corporate Seal Here)

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF DOCUMENT 004113

DOCUMENT 00 60 00 - PROJECT FORMS

PART 1 - GENERAL

1.1 FORM OF AGREEMENT AND GENERAL CONDITIONS

A. The following form of Owner/Contractor Agreement and form of the General Conditions to be used for Project:

1. AIA Document A101-2017 "Standard Form of Agreement between Owner and Contractor Where the Basis of Payment is a Stipulated Sum."

    a. The General Conditions for Project are AIA Document A201-2017 "General Conditions of the Contract for Construction."

2. The General Conditions are included in the Project Manual.
3. The Supplementary Conditions for Project are separately prepared and included in the Project Manual.
4. Owner's document(s) bound following this Document.

1.2 ADMINISTRATIVE FORMS

A. Administrative Forms: Additional administrative forms are specified in Division 01 General Requirements.

B. Copies of AIA standard forms may be obtained from AIA Contract Documents: https://aiacontracts.com.

C. Preconstruction Forms:

1. Form of Performance Bond and Labor and Material Bond: AIA Document A312-2010 "Performance Bond" and AIA Document A312-2010 "Payment Bond."
2. Form of Certificate of Insurance: AIA Document G715-2017 "Supplemental Attachment for ACORD Certificate of Insurance 25."

D. Information and Modification Forms:

1. Form for Requests for Information (RFIs): AIA Document G716-2004 "Request for Information (RFI)."
2. Form of Request for Proposal: AIA Document G709-2018 "Proposal Request."
3. Change Order Form: AIA Document G701-2017 "Change Order."

E. Payment Forms:

1. Schedule of Values Form: AIA Document G703-1992 "Continuation Sheet."
2. Payment Application, Lump Sum Project: AIA Document G702-1992 "Application and Certificate for Payment" and G703-1992 "Continuation Sheet."
3. Form of Affidavit of Release of Liens on Progress Payments: AIA Document

G901-2022 "Conditional Waiver and Release on Progress Payment".

4. Form of Affidavit of Release of Liens on Final Payments: AIA Document G904-2022 "Unconditional Waiver and Release on Final Payment".

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF DOCUMENT 00 60 00

DOCUMENT 00 63 13.16 - REQUEST FOR INTERPRETATION FORM (RFI), CONSTRUCTION PHASE

PART 1 - GENERAL

1.1 SUMMARY

A. Contractor: Utilize this form to request information required by or clarifications of the Contract Documents.

B. Refer to Section 013100 "Project Management and Coordination" for instructions for submittal of this form and for definitions used on this form.

1.2 PROJECT INFORMATION

A. Project Name: TM Aviation Hangar at LXT.

B. Owner: TM Aviation.

C. Architect: Wellner Architects + Engineer.

D. Architect Project Number: 2404.

1.3 REQUEST INFORMATION

A. Contractor: _____. Email: _____.

B. Specification Section and Paragraph No.: _____.

C. Drawing Sheet/Detail Number: _____.

1.4 INQUIRY

A. Contractor's Inquiry:
_____
_____
_____
_____
_____
_____.

B. Contractor's Suggested Resolution:

_____
_____
_____
_____
_____
_____
_____
_____.

C. Attachments:
_____
_____
_____
_____
_____
_____
_____
_____.

D. Signed:
_____
_

E. Date:
_____
___

1.5 RESPONSE

A. Architect's Response:
_____
_____
_____
_____
_____.

B. Signed:
_____
_

C. Date:
_____
___

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF DOCUMENT 00 63 13.16

SECTION 00 72 00 - GENERAL CONDITIONS

PART 1 - GENERAL

1.1 INSTRUCTIONS TO BIDDERS

A. AIA Document A201-2017, "General Conditions," is hereby incorporated into the Bidding Documents by reference.

1. Document 00 73 00 "Supplementary Conditions" is bound in this Project Manual.
2. A Copy of AIA Document A201-2017 "General Conditions." is bound in this Project Manual.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 00 72 00

AIA® Document A201® – 2017

General Conditions of the Contract for Construction

for the following PROJECT:
(Name and location or address)

THE OWNER:
(Name, legal status and address)

THE ARCHITECT:
(Name, legal status and address)

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.

For guidance in modifying this document to include supplementary conditions, see AIA Document A503™, Guide for Supplementary Conditions.

TABLE OF ARTICLES

INDEX
(Topics and numbers in bold are Section headings.)

ARTICLE 1 GENERAL PROVISIONS

§ 1.1 Basic Definitions

§ 1.1.1 The Contract Documents

The Contract Documents are enumerated in the Agreement between the Owner and Contractor (hereinafter the Agreement) and consist of the Agreement, Conditions of the Contract (General, Supplementary and other Conditions), Drawings, Specifications, Addenda issued prior to execution of the Contract, other documents listed in the Agreement, and Modifications issued after execution of the Contract. A Modification is (1) a written amendment to the Contract signed by both parties, (2) a Change Order, (3) a Construction Change Directive, or (4) a written order for a minor change in the Work issued by the Architect. Unless specifically enumerated in the Agreement, the Contract Documents do not include the advertisement or invitation to bid, Instructions to Bidders, sample forms, other information furnished by the Owner in anticipation of receiving bids or proposals, the Contractor's bid or proposal, or portions of Addenda relating to bidding or proposal requirements.

§ 1.1.2 The Contract

The Contract Documents form the Contract for Construction. The Contract represents the entire and integrated agreement between the parties hereto and supersedes prior negotiations, representations, or agreements, either written or oral. The Contract may be amended or modified only by a Modification. The Contract Documents shall not be construed to create a contractual relationship of any kind (1) between the Contractor and the Architect or the Architect's consultants, (2) between the Owner and a Subcontractor or a Sub-subcontractor, (3) between the Owner and the Architect or the Architect's consultants, or (4) between any persons or entities other than the Owner and the Contractor. The Architect shall, however, be entitled to performance and enforcement of obligations under the Contract intended to facilitate performance of the Architect's duties.

§ 1.1.3 The Work

The term "Work" means the construction and services required by the Contract Documents, whether completed or partially completed, and includes all other labor, materials, equipment, and services provided or to be provided by the Contractor to fulfill the Contractor's obligations. The Work may constitute the whole or a part of the Project.

§ 1.1.4 The Project

The Project is the total construction of which the Work performed under the Contract Documents may be the whole or a part and which may include construction by the Owner and by Separate Contractors.

§ 1.1.5 The Drawings

The Drawings are the graphic and pictorial portions of the Contract Documents showing the design, location and dimensions of the Work, generally including plans, elevations, sections, details, schedules, and diagrams.

§ 1.1.6 The Specifications

The Specifications are that portion of the Contract Documents consisting of the written requirements for materials, equipment, systems, standards and workmanship for the Work, and performance of related services.

§ 1.1.7 Instruments of Service

Instruments of Service are representations, in any medium of expression now known or later developed, of the tangible and intangible creative work performed by the Architect and the Architect's consultants under their respective professional services agreements. Instruments of Service may include, without limitation, studies, surveys, models, sketches, drawings, specifications, and other similar materials.

§ 1.1.8 Initial Decision Maker

The Initial Decision Maker is the person identified in the Agreement to render initial decisions on Claims in accordance with Section 15.2. The Initial Decision Maker shall not show partiality to the Owner or Contractor and shall not be liable for results of interpretations or decisions rendered in good faith.

§ 1.2 Correlation and Intent of the Contract Documents

§ 1.2.1 The intent of the Contract Documents is to include all items necessary for the proper execution and completion of the Work by the Contractor. The Contract Documents are complementary, and what is required by one shall be as binding as if required by all; performance by the Contractor shall be required only to the extent consistent with the Contract Documents and reasonably inferable from them as being necessary to produce the indicated results.

§ 1.2.1.1 The invalidity of any provision of the Contract Documents shall not invalidate the Contract or its remaining

provisions. If it is determined that any provision of the Contract Documents violates any law, or is otherwise invalid or unenforceable, then that provision shall be revised to the extent necessary to make that provision legal and enforceable. In such case the Contract Documents shall be construed, to the fullest extent permitted by law, to give effect to the parties' intentions and purposes in executing the Contract.

§ 1.2.2 Organization of the Specifications into divisions, sections and articles, and arrangement of Drawings shall not control the Contractor in dividing the Work among Subcontractors or in establishing the extent of Work to be performed by any trade.

§ 1.2.3 Unless otherwise stated in the Contract Documents, words that have well-known technical or construction industry meanings are used in the Contract Documents in accordance with such recognized meanings.

§ 1.3 Capitalization

Terms capitalized in these General Conditions include those that are (1) specifically defined, (2) the titles of numbered articles, or (3) the titles of other documents published by the American Institute of Architects.

§ 1.4 Interpretation

In the interest of brevity the Contract Documents frequently omit modifying words such as "all" and "any" and articles such as "the" and "an," but the fact that a modifier or an article is absent from one statement and appears in another is not intended to affect the interpretation of either statement.

§ 1.5 Ownership and Use of Drawings, Specifications, and Other Instruments of Service

§ 1.5.1 The Architect and the Architect's consultants shall be deemed the authors and owners of their respective Instruments of Service, including the Drawings and Specifications, and retain all common law, statutory, and other reserved rights in their Instruments of Service, including copyrights. The Contractor, Subcontractors, Sub-subcontractors, and suppliers shall not own or claim a copyright in the Instruments of Service. Submittal or distribution to meet official regulatory requirements or for other purposes in connection with the Project is not to be construed as publication in derogation of the Architect's or Architect's consultants' reserved rights.

§ 1.5.2 The Contractor, Subcontractors, Sub-subcontractors, and suppliers are authorized to use and reproduce the Instruments of Service provided to them, subject to any protocols established pursuant to Sections 1.7 and 1.8, solely and exclusively for execution of the Work. All copies made under this authorization shall bear the copyright notice, if any, shown on the Instruments of Service. The Contractor, Subcontractors, Sub-subcontractors, and suppliers may not use the Instruments of Service on other projects or for additions to the Project outside the scope of the Work without the specific written consent of the Owner, Architect, and the Architect's consultants.

§ 1.6 Notice

§ 1.6.1 Except as otherwise provided in Section 1.6.2, where the Contract Documents require one party to notify or give notice to the other party, such notice shall be provided in writing to the designated representative of the party to whom the notice is addressed and shall be deemed to have been duly served if delivered in person, by mail, by courier, or by electronic transmission if a method for electronic transmission is set forth in the Agreement.

§ 1.6.2 Notice of Claims as provided in Section 15.1.3 shall be provided in writing and shall be deemed to have been duly served only if delivered to the designated representative of the party to whom the notice is addressed by certified or registered mail, or by courier providing proof of delivery.

§ 1.7 Digital Data Use and Transmission

The parties shall agree upon written protocols governing the transmission and use of, and reliance on, Instruments of Service or any other information or documentation in digital form.

§ 1.8 Building Information Models Use and Reliance

Any use of, or reliance on, all or a portion of a building information model without agreement to written protocols governing the use of, and reliance on, the information contained in the model shall be at the using or relying party's sole risk and without liability to the other party and its contractors or consultants, the authors of, or contributors to, the building information model, and each of their agents and employees.

ARTICLE 2 OWNER

§ 2.1 General

§ 2.1.1 The Owner is the person or entity identified as such in the Agreement and is referred to throughout the Contract Documents as if singular in number. The Owner shall designate in writing a representative who shall have express authority to bind the Owner with respect to all matters requiring the Owner's approval or authorization. Except as otherwise provided in Section 4.2.1, the Architect does not have such authority. The term "Owner" means the Owner or the Owner's authorized representative.

§ 2.1.2 The Owner shall furnish to the Contractor, within fifteen days after receipt of a written request, information necessary and relevant for the Contractor to evaluate, give notice of, or enforce mechanic's lien rights. Such information shall include a correct statement of the record legal title to the property on which the Project is located, usually referred to as the site, and the Owner's interest therein.

§ 2.2 Evidence of the Owner's Financial Arrangements

§ 2.2.1 Prior to commencement of the Work and upon written request by the Contractor, the Owner shall furnish to the Contractor reasonable evidence that the Owner has made financial arrangements to fulfill the Owner's obligations under the Contract. The Contractor shall have no obligation to commence the Work until the Owner provides such evidence. If commencement of the Work is delayed under this Section 2.2.1, the Contract Time shall be extended appropriately.

§ 2.2.2 Following commencement of the Work and upon written request by the Contractor, the Owner shall furnish to the Contractor reasonable evidence that the Owner has made financial arrangements to fulfill the Owner's obligations under the Contract only if (1) the Owner fails to make payments to the Contractor as the Contract Documents require; (2) the Contractor identifies in writing a reasonable concern regarding the Owner's ability to make payment when due; or (3) a change in the Work materially changes the Contract Sum. If the Owner fails to provide such evidence, as required, within fourteen days of the Contractor's request, the Contractor may immediately stop the Work and, in that event, shall notify the Owner that the Work has stopped. However, if the request is made because a change in the Work materially changes the Contract Sum under (3) above, the Contractor may immediately stop only that portion of the Work affected by the change until reasonable evidence is provided. If the Work is stopped under this Section 2.2.2, the Contract Time shall be extended appropriately and the Contract Sum shall be increased by the amount of the Contractor's reasonable costs of shutdown, delay and start-up, plus interest as provided in the Contract Documents.

§ 2.2.3 After the Owner furnishes evidence of financial arrangements under this Section 2.2, the Owner shall not materially vary such financial arrangements without prior notice to the Contractor.

§ 2.2.4 Where the Owner has designated information furnished under this Section 2.2 as "confidential," the Contractor shall keep the information confidential and shall not disclose it to any other person. However, the Contractor may disclose "confidential" information, after seven (7) days' notice to the Owner, where disclosure is required by law, including a subpoena or other form of compulsory legal process issued by a court or governmental entity, or by court or arbitrator(s) order. The Contractor may also disclose "confidential" information to its employees, consultants, sureties, Subcontractors and their employees, Sub-subcontractors, and others who need to know the content of such information solely and exclusively for the Project and who agree to maintain the confidentiality of such information.

§ 2.3 Information and Services Required of the Owner

§ 2.3.1 Except for permits and fees that are the responsibility of the Contractor under the Contract Documents, including those required under Section 3.7.1, the Owner shall secure and pay for necessary approvals, easements, assessments and charges required for construction, use or occupancy of permanent structures or for permanent changes in existing facilities.

§ 2.3.2 The Owner shall retain an architect lawfully licensed to practice architecture, or an entity lawfully practicing architecture, in the jurisdiction where the Project is located. That person or entity is identified as the Architect in the Agreement and is referred to throughout the Contract Documents as if singular in number.

§ 2.3.3 If the employment of the Architect terminates, the Owner shall employ a successor to whom the Contractor has no reasonable objection and whose status under the Contract Documents shall be that of the Architect.

§ 2.3.4 The Owner shall furnish surveys describing physical characteristics, legal limitations and utility locations for the

site of the Project, and a legal description of the site. The Contractor shall be entitled to rely on the accuracy of information furnished by the Owner but shall exercise proper precautions relating to the safe performance of the Work.

§ 2.3.5 The Owner shall furnish information or services required of the Owner by the Contract Documents with reasonable promptness. The Owner shall also furnish any other information or services under the Owner's control and relevant to the Contractor's performance of the Work with reasonable promptness after receiving the Contractor's written request for such information or services.

§ 2.3.6 Unless otherwise provided in the Contract Documents, the Owner shall furnish to the Contractor one copy of the Contract Documents for purposes of making reproductions pursuant to Section 1.5.2.

§ 2.4 Owner's Right to Stop the Work

If the Contractor fails to correct Work that is not in accordance with the requirements of the Contract Documents as required by Section 12.2 or repeatedly fails to carry out Work in accordance with the Contract Documents, the Owner may issue a written order to the Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, the right of the Owner to stop the Work shall not give rise to a duty on the part of the Owner to exercise this right for the benefit of the Contractor or any other person or entity, except to the extent required by Section 6.1.3.

§ 2.5 Owner's Right to Carry Out the Work

If the Contractor defaults or neglects to carry out the Work in accordance with the Contract Documents and fails within a ten-day period after receipt of notice from the Owner to commence and continue correction of such default or neglect with diligence and promptness, the Owner may, without prejudice to other remedies the Owner may have, correct such default or neglect. Such action by the Owner and amounts charged to the Contractor are both subject to prior approval of the Architect and the Architect may, pursuant to Section 9.5.1, withhold or nullify a Certificate for Payment in whole or in part, to the extent reasonably necessary to reimburse the Owner for the reasonable cost of correcting such deficiencies, including Owner's expenses and compensation for the Architect's additional services made necessary by such default, neglect, or failure. If current and future payments are not sufficient to cover such amounts, the Contractor shall pay the difference to the Owner. If the Contractor disagrees with the actions of the Owner or the Architect, or the amounts claimed as costs to the Owner, the Contractor may file a Claim pursuant to Article 15.

ARTICLE 3 CONTRACTOR

§ 3.1 General

§ 3.1.1 The Contractor is the person or entity identified as such in the Agreement and is referred to throughout the Contract Documents as if singular in number. The Contractor shall be lawfully licensed, if required in the jurisdiction where the Project is located. The Contractor shall designate in writing a representative who shall have express authority to bind the Contractor with respect to all matters under this Contract. The term "Contractor" means the Contractor or the Contractor's authorized representative.

§ 3.1.2 The Contractor shall perform the Work in accordance with the Contract Documents.

§ 3.1.3 The Contractor shall not be relieved of its obligations to perform the Work in accordance with the Contract Documents either by activities or duties of the Architect in the Architect's administration of the Contract, or by tests, inspections or approvals required or performed by persons or entities other than the Contractor.

§ 3.2 Review of Contract Documents and Field Conditions by Contractor

§ 3.2.1 Execution of the Contract by the Contractor is a representation that the Contractor has visited the site, become generally familiar with local conditions under which the Work is to be performed, and correlated personal observations with requirements of the Contract Documents.

§ 3.2.2 Because the Contract Documents are complementary, the Contractor shall, before starting each portion of the Work, carefully study and compare the various Contract Documents relative to that portion of the Work, as well as the information furnished by the Owner pursuant to Section 2.3.4, shall take field measurements of any existing conditions related to that portion of the Work, and shall observe any conditions at the site affecting it. These obligations are for the purpose of facilitating coordination and construction by the Contractor and are not for the purpose of discovering errors, omissions, or inconsistencies in the Contract Documents; however, the Contractor shall promptly report to the Architect any errors, inconsistencies or omissions discovered by or made known to the Contractor as a request for information in such form as the Architect may require. It is recognized that the Contractor's review is made in the Contractor's

remedy for damage or defect caused by abuse, alterations to the Work not executed by the Contractor, improper or insufficient maintenance, improper operation, or normal wear and tear and normal usage. If required by the Architect, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment.

§ 3.5.2 All material, equipment, or other special warranties required by the Contract Documents shall be issued in the name of the Owner, or shall be transferable to the Owner, and shall commence in accordance with Section 9.8.4.

§ 3.6 Taxes

The Contractor shall pay sales, consumer, use and similar taxes for the Work provided by the Contractor that are legally enacted when bids are received or negotiations concluded, whether or not yet effective or merely scheduled to go into effect.

§ 3.7 Permits, Fees, Notices and Compliance with Laws

§ 3.7.1 Unless otherwise provided in the Contract Documents, the Contractor shall secure and pay for the building permit as well as for other permits, fees, licenses, and inspections by government agencies necessary for proper execution and completion of the Work that are customarily secured after execution of the Contract and legally required at the time bids are received or negotiations concluded.

§ 3.7.2 The Contractor shall comply with and give notices required by applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities applicable to performance of the Work.

§ 3.7.3 If the Contractor performs Work knowing it to be contrary to applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of public authorities, the Contractor shall assume appropriate responsibility for such Work and shall bear the costs attributable to correction.

§ 3.7.4 Concealed or Unknown Conditions

If the Contractor encounters conditions at the site that are (1) subsurface or otherwise concealed physical conditions that differ materially from those indicated in the Contract Documents or (2) unknown physical conditions of an unusual nature that differ materially from those ordinarily found to exist and generally recognized as inherent in construction activities of the character provided for in the Contract Documents, the Contractor shall promptly provide notice to the Owner and the Architect before conditions are disturbed and in no event later than 14 days after first observance of the conditions. The Architect will promptly investigate such conditions and, if the Architect determines that they differ materially and cause an increase or decrease in the Contractor's cost of, or time required for, performance of any part of the Work, will recommend that an equitable adjustment be made in the Contract Sum or Contract Time, or both. If the Architect determines that the conditions at the site are not materially different from those indicated in the Contract Documents and that no change in the terms of the Contract is justified, the Architect shall promptly notify the Owner and Contractor, stating the reasons. If either party disputes the Architect's determination or recommendation, that party may submit a Claim as provided in Article 15.

§ 3.7.5 If, in the course of the Work, the Contractor encounters human remains or recognizes the existence of burial markers, archaeological sites or wetlands not indicated in the Contract Documents, the Contractor shall immediately suspend any operations that would affect them and shall notify the Owner and Architect. Upon receipt of such notice, the Owner shall promptly take any action necessary to obtain governmental authorization required to resume the operations. The Contractor shall continue to suspend such operations until otherwise instructed by the Owner but shall continue with all other operations that do not affect those remains or features. Requests for adjustments in the Contract Sum and Contract Time arising from the existence of such remains or features may be made as provided in Article 15.

§ 3.8 Allowances

§ 3.8.1 The Contractor shall include in the Contract Sum all allowances stated in the Contract Documents. Items covered by allowances shall be supplied for such amounts and by such persons or entities as the Owner may direct, but the Contractor shall not be required to employ persons or entities to whom the Contractor has reasonable objection.

§ 3.8.2 Unless otherwise provided in the Contract Documents,

- **.1** allowances shall cover the cost to the Contractor of materials and equipment delivered at the site and all required taxes, less applicable trade discounts;
- **.2** Contractor's costs for unloading and handling at the site, labor, installation costs, overhead, profit, and other expenses contemplated for stated allowance amounts shall be included in the Contract Sum but not in the allowances; and

.3 whenever costs are more than or less than allowances, the Contract Sum shall be adjusted accordingly by Change Order. The amount of the Change Order shall reflect (1) the difference between actual costs and the allowances under Section 3.8.2.1 and (2) changes in Contractor's costs under Section 3.8.2.2.

§ 3.8.3 Materials and equipment under an allowance shall be selected by the Owner with reasonable promptness.

§ 3.9 Superintendent

§ 3.9.1 The Contractor shall employ a competent superintendent and necessary assistants who shall be in attendance at the Project site during performance of the Work. The superintendent shall represent the Contractor, and communications given to the superintendent shall be as binding as if given to the Contractor.

§ 3.9.2 The Contractor, as soon as practicable after award of the Contract, shall notify the Owner and Architect of the name and qualifications of a proposed superintendent. Within 14 days of receipt of the information, the Architect may notify the Contractor, stating whether the Owner or the Architect (1) has reasonable objection to the proposed superintendent or (2) requires additional time for review. Failure of the Architect to provide notice within the 14-day period shall constitute notice of no reasonable objection.

§ 3.9.3 The Contractor shall not employ a proposed superintendent to whom the Owner or Architect has made reasonable and timely objection. The Contractor shall not change the superintendent without the Owner's consent, which shall not unreasonably be withheld or delayed.

§ 3.10 Contractor's Construction and Submittal Schedules

§ 3.10.1 The Contractor, promptly after being awarded the Contract, shall submit for the Owner's and Architect's information a Contractor's construction schedule for the Work. The schedule shall contain detail appropriate for the Project, including (1) the date of commencement of the Work, interim schedule milestone dates, and the date of Substantial Completion; (2) an apportionment of the Work by construction activity; and (3) the time required for completion of each portion of the Work. The schedule shall provide for the orderly progression of the Work to completion and shall not exceed time limits current under the Contract Documents. The schedule shall be revised at appropriate intervals as required by the conditions of the Work and Project.

§ 3.10.2 The Contractor, promptly after being awarded the Contract and thereafter as necessary to maintain a current submittal schedule, shall submit a submittal schedule for the Architect's approval. The Architect's approval shall not be unreasonably delayed or withheld. The submittal schedule shall (1) be coordinated with the Contractor's construction schedule, and (2) allow the Architect reasonable time to review submittals. If the Contractor fails to submit a submittal schedule, or fails to provide submittals in accordance with the approved submittal schedule, the Contractor shall not be entitled to any increase in Contract Sum or extension of Contract Time based on the time required for review of submittals.

§ 3.10.3 The Contractor shall perform the Work in general accordance with the most recent schedules submitted to the Owner and Architect.

§ 3.11 Documents and Samples at the Site

The Contractor shall make available, at the Project site, the Contract Documents, including Change Orders, Construction Change Directives, and other Modifications, in good order and marked currently to indicate field changes and selections made during construction, and the approved Shop Drawings, Product Data, Samples, and similar required submittals. These shall be in electronic form or paper copy, available to the Architect and Owner, and delivered to the Architect for submittal to the Owner upon completion of the Work as a record of the Work as constructed.

§ 3.12 Shop Drawings, Product Data and Samples

§ 3.12.1 Shop Drawings are drawings, diagrams, schedules, and other data specially prepared for the Work by the Contractor or a Subcontractor, Sub-subcontractor, manufacturer, supplier, or distributor to illustrate some portion of the Work.

§ 3.12.2 Product Data are illustrations, standard schedules, performance charts, instructions, brochures, diagrams, and other information furnished by the Contractor to illustrate materials or equipment for some portion of the Work.

§ 3.12.3 Samples are physical examples that illustrate materials, equipment, or workmanship, and establish standards by which the Work will be judged.

§ 3.12.4 Shop Drawings, Product Data, Samples, and similar submittals are not Contract Documents. Their purpose is to demonstrate how the Contractor proposes to conform to the information given and the design concept expressed in the Contract Documents for those portions of the Work for which the Contract Documents require submittals. Review by the Architect is subject to the limitations of Section 4.2.7. Informational submittals upon which the Architect is not expected to take responsive action may be so identified in the Contract Documents. Submittals that are not required by the Contract Documents may be returned by the Architect without action.

§ 3.12.5 The Contractor shall review for compliance with the Contract Documents, approve, and submit to the Architect, Shop Drawings, Product Data, Samples, and similar submittals required by the Contract Documents, in accordance with the submittal schedule approved by the Architect or, in the absence of an approved submittal schedule, with reasonable promptness and in such sequence as to cause no delay in the Work or in the activities of the Owner or of Separate Contractors.

§ 3.12.6 By submitting Shop Drawings, Product Data, Samples, and similar submittals, the Contractor represents to the Owner and Architect that the Contractor has (1) reviewed and approved them, (2) determined and verified materials, field measurements and field construction criteria related thereto, or will do so, and (3) checked and coordinated the information contained within such submittals with the requirements of the Work and of the Contract Documents.

§ 3.12.7 The Contractor shall perform no portion of the Work for which the Contract Documents require submittal and review of Shop Drawings, Product Data, Samples, or similar submittals, until the respective submittal has been approved by the Architect.

§ 3.12.8 The Work shall be in accordance with approved submittals except that the Contractor shall not be relieved of responsibility for deviations from the requirements of the Contract Documents by the Architect's approval of Shop Drawings, Product Data, Samples, or similar submittals, unless the Contractor has specifically notified the Architect of such deviation at the time of submittal and (1) the Architect has given written approval to the specific deviation as a minor change in the Work, or (2) a Change Order or Construction Change Directive has been issued authorizing the deviation. The Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples, or similar submittals, by the Architect's approval thereof.

§ 3.12.9 The Contractor shall direct specific attention, in writing or on resubmitted Shop Drawings, Product Data, Samples, or similar submittals, to revisions other than those requested by the Architect on previous submittals. In the absence of such notice, the Architect's approval of a resubmission shall not apply to such revisions.

§ 3.12.10 The Contractor shall not be required to provide professional services that constitute the practice of architecture or engineering unless such services are specifically required by the Contract Documents for a portion of the Work or unless the Contractor needs to provide such services in order to carry out the Contractor's responsibilities for construction means, methods, techniques, sequences, and procedures. The Contractor shall not be required to provide professional services in violation of applicable law.

§ 3.12.10.1 If professional design services or certifications by a design professional related to systems, materials, or equipment are specifically required of the Contractor by the Contract Documents, the Owner and the Architect will specify all performance and design criteria that such services must satisfy. The Contractor shall be entitled to rely upon the adequacy and accuracy of the performance and design criteria provided in the Contract Documents. The Contractor shall cause such services or certifications to be provided by an appropriately licensed design professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings, and other submittals prepared by such professional. Shop Drawings, and other submittals related to the Work, designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to the Architect. The Owner and the Architect shall be entitled to rely upon the adequacy and accuracy of the services, certifications, and approvals performed or provided by such design professionals, provided the Owner and Architect have specified to the Contractor the performance and design criteria that such services must satisfy. Pursuant to this Section 3.12.10, the Architect will review and approve or take other appropriate action on submittals only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents.

§ 3.12.10.2 If the Contract Documents require the Contractor's design professional to certify that the Work has been performed in accordance with the design criteria, the Contractor shall furnish such certifications to the Architect at the

time and in the form specified by the Architect.

§ 3.13 Use of Site

The Contractor shall confine operations at the site to areas permitted by applicable laws, statutes, ordinances, codes, rules and regulations, lawful orders of public authorities, and the Contract Documents and shall not unreasonably encumber the site with materials or equipment.

§ 3.14 Cutting and Patching

§ 3.14.1 The Contractor shall be responsible for cutting, fitting, or patching required to complete the Work or to make its parts fit together properly. All areas requiring cutting, fitting, or patching shall be restored to the condition existing prior to the cutting, fitting, or patching, unless otherwise required by the Contract Documents.

§ 3.14.2 The Contractor shall not damage or endanger a portion of the Work or fully or partially completed construction of the Owner or Separate Contractors by cutting, patching, or otherwise altering such construction, or by excavation. The Contractor shall not cut or otherwise alter construction by the Owner or a Separate Contractor except with written consent of the Owner and of the Separate Contractor. Consent shall not be unreasonably withheld. The Contractor shall not unreasonably withhold, from the Owner or a Separate Contractor, its consent to cutting or otherwise altering the Work.

§ 3.15 Cleaning Up

§ 3.15.1 The Contractor shall keep the premises and surrounding area free from accumulation of waste materials and rubbish caused by operations under the Contract. At completion of the Work, the Contractor shall remove waste materials, rubbish, the Contractor's tools, construction equipment, machinery, and surplus materials from and about the Project.

§ 3.15.2 If the Contractor fails to clean up as provided in the Contract Documents, the Owner may do so and the Owner shall be entitled to reimbursement from the Contractor.

§ 3.16 Access to Work

The Contractor shall provide the Owner and Architect with access to the Work in preparation and progress wherever located.

§ 3.17 Royalties, Patents and Copyrights

The Contractor shall pay all royalties and license fees. The Contractor shall defend suits or claims for infringement of copyrights and patent rights and shall hold the Owner and Architect harmless from loss on account thereof, but shall not be responsible for defense or loss when a particular design, process, or product of a particular manufacturer or manufacturers is required by the Contract Documents, or where the copyright violations are contained in Drawings, Specifications, or other documents prepared by the Owner or Architect. However, if an infringement of a copyright or patent is discovered by, or made known to, the Contractor, the Contractor shall be responsible for the loss unless the information is promptly furnished to the Architect.

§ 3.18 Indemnification

§ 3.18.1 To the fullest extent permitted by law, the Contractor shall indemnify and hold harmless the Owner, Architect, Architect's consultants, and agents and employees of any of them from and against claims, damages, losses, and expenses, including but not limited to attorneys' fees, arising out of or resulting from performance of the Work, provided that such claim, damage, loss, or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself), but only to the extent caused by the negligent acts or omissions of the Contractor, a Subcontractor, anyone directly or indirectly employed by them, or anyone for whose acts they may be liable, regardless of whether or not such claim, damage, loss, or expense is caused in part by a party indemnified hereunder. Such obligation shall not be construed to negate, abridge, or reduce other rights or obligations of indemnity that would otherwise exist as to a party or person described in this Section 3.18.

§ 3.18.2 In claims against any person or entity indemnified under this Section 3.18 by an employee of the Contractor, a Subcontractor, anyone directly or indirectly employed by them, or anyone for whose acts they may be liable, the indemnification obligation under Section 3.18.1 shall not be limited by a limitation on amount or type of damages, compensation, or benefits payable by or for the Contractor or a Subcontractor under workers' compensation acts, disability benefit acts, or other employee benefit acts.

ARTICLE 4 ARCHITECT

§ 4.1 General

§ 4.1.1 The Architect is the person or entity retained by the Owner pursuant to Section 2.3.2 and identified as such in the Agreement.

§ 4.1.2 Duties, responsibilities, and limitations of authority of the Architect as set forth in the Contract Documents shall not be restricted, modified, or extended without written consent of the Owner, Contractor, and Architect. Consent shall not be unreasonably withheld.

§ 4.2 Administration of the Contract

§ 4.2.1 The Architect will provide administration of the Contract as described in the Contract Documents and will be an Owner's representative during construction until the date the Architect issues the final Certificate for Payment. The Architect will have authority to act on behalf of the Owner only to the extent provided in the Contract Documents.

§ 4.2.2 The Architect will visit the site at intervals appropriate to the stage of construction, or as otherwise agreed with the Owner, to become generally familiar with the progress and quality of the portion of the Work completed, and to determine in general if the Work observed is being performed in a manner indicating that the Work, when fully completed, will be in accordance with the Contract Documents. However, the Architect will not be required to make exhaustive or continuous on-site inspections to check the quality or quantity of the Work. The Architect will not have control over, charge of, or responsibility for the construction means, methods, techniques, sequences or procedures, or for the safety precautions and programs in connection with the Work, since these are solely the Contractor's rights and responsibilities under the Contract Documents.

§ 4.2.3 On the basis of the site visits, the Architect will keep the Owner reasonably informed about the progress and quality of the portion of the Work completed, and promptly report to the Owner (1) known deviations from the Contract Documents, (2) known deviations from the most recent construction schedule submitted by the Contractor, and (3) defects and deficiencies observed in the Work. The Architect will not be responsible for the Contractor's failure to perform the Work in accordance with the requirements of the Contract Documents. The Architect will not have control over or charge of, and will not be responsible for acts or omissions of, the Contractor, Subcontractors, or their agents or employees, or any other persons or entities performing portions of the Work.

§ 4.2.4 Communications

The Owner and Contractor shall include the Architect in all communications that relate to or affect the Architect's services or professional responsibilities. The Owner shall promptly notify the Architect of the substance of any direct communications between the Owner and the Contractor otherwise relating to the Project. Communications by and with the Architect's consultants shall be through the Architect. Communications by and with Subcontractors and suppliers shall be through the Contractor. Communications by and with Separate Contractors shall be through the Owner. The Contract Documents may specify other communication protocols.

§ 4.2.5 Based on the Architect's evaluations of the Contractor's Applications for Payment, the Architect will review and certify the amounts due the Contractor and will issue Certificates for Payment in such amounts.

§ 4.2.6 The Architect has authority to reject Work that does not conform to the Contract Documents. Whenever the Architect considers it necessary or advisable, the Architect will have authority to require inspection or testing of the Work in accordance with Sections 13.4.2 and 13.4.3, whether or not the Work is fabricated, installed or completed. However, neither this authority of the Architect nor a decision made in good faith either to exercise or not to exercise such authority shall give rise to a duty or responsibility of the Architect to the Contractor, Subcontractors, suppliers, their agents or employees, or other persons or entities performing portions of the Work.

§ 4.2.7 The Architect will review and approve, or take other appropriate action upon, the Contractor's submittals such as Shop Drawings, Product Data, and Samples, but only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. The Architect's action will be taken in accordance with the submittal schedule approved by the Architect or, in the absence of an approved submittal schedule, with reasonable promptness while allowing sufficient time in the Architect's professional judgment to permit adequate review. Review of such submittals is not conducted for the purpose of determining the accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems, all of which remain the responsibility of the Contractor as required by the Contract Documents. The Architect's review of the Contractor's submittals shall not relieve the Contractor of the obligations under

Sections 3.3, 3.5, and 3.12. The Architect's review shall not constitute approval of safety precautions or of any construction means, methods, techniques, sequences, or procedures. The Architect's approval of a specific item shall not indicate approval of an assembly of which the item is a component.

§ 4.2.8 The Architect will prepare Change Orders and Construction Change Directives, and may order minor changes in the Work as provided in Section 7.4. The Architect will investigate and make determinations and recommendations regarding concealed and unknown conditions as provided in Section 3.7.4.

§ 4.2.9 The Architect will conduct inspections to determine the date or dates of Substantial Completion and the date of final completion; issue Certificates of Substantial Completion pursuant to Section 9.8; receive and forward to the Owner, for the Owner's review and records, written warranties and related documents required by the Contract and assembled by the Contractor pursuant to Section 9.10; and issue a final Certificate for Payment pursuant to Section 9.10.

§ 4.2.10 If the Owner and Architect agree, the Architect will provide one or more Project representatives to assist in carrying out the Architect's responsibilities at the site. The Owner shall notify the Contractor of any change in the duties, responsibilities and limitations of authority of the Project representatives.

§ 4.2.11 The Architect will interpret and decide matters concerning performance under, and requirements of, the Contract Documents on written request of either the Owner or Contractor. The Architect's response to such requests will be made in writing within any time limits agreed upon or otherwise with reasonable promptness.

§ 4.2.12 Interpretations and decisions of the Architect will be consistent with the intent of, and reasonably inferable from, the Contract Documents and will be in writing or in the form of drawings. When making such interpretations and decisions, the Architect will endeavor to secure faithful performance by both Owner and Contractor, will not show partiality to either, and will not be liable for results of interpretations or decisions rendered in good faith.

§ 4.2.13 The Architect's decisions on matters relating to aesthetic effect will be final if consistent with the intent expressed in the Contract Documents.

§ 4.2.14 The Architect will review and respond to requests for information about the Contract Documents. The Architect's response to such requests will be made in writing within any time limits agreed upon or otherwise with reasonable promptness. If appropriate, the Architect will prepare and issue supplemental Drawings and Specifications in response to the requests for information.

ARTICLE 5 SUBCONTRACTORS

§ 5.1 Definitions

§ 5.1.1 A Subcontractor is a person or entity who has a direct contract with the Contractor to perform a portion of the Work at the site. The term "Subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Subcontractor or an authorized representative of the Subcontractor. The term "Subcontractor" does not include a Separate Contractor or the subcontractors of a Separate Contractor.

§ 5.1.2 A Sub-subcontractor is a person or entity who has a direct or indirect contract with a Subcontractor to perform a portion of the Work at the site. The term "Sub-subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Sub-subcontractor or an authorized representative of the Sub-subcontractor.

§ 5.2 Award of Subcontracts and Other Contracts for Portions of the Work

§ 5.2.1 Unless otherwise stated in the Contract Documents, the Contractor, as soon as practicable after award of the Contract, shall notify the Owner and Architect of the persons or entities proposed for each principal portion of the Work, including those who are to furnish materials or equipment fabricated to a special design. Within 14 days of receipt of the information, the Architect may notify the Contractor whether the Owner or the Architect (1) has reasonable objection to any such proposed person or entity or (2) requires additional time for review. Failure of the Architect to provide notice within the 14-day period shall constitute notice of no reasonable objection.

§ 5.2.2 The Contractor shall not contract with a proposed person or entity to whom the Owner or Architect has made reasonable and timely objection. The Contractor shall not be required to contract with anyone to whom the Contractor has made reasonable objection.

§ 5.2.3 If the Owner or Architect has reasonable objection to a person or entity proposed by the Contractor, the

Contractor shall propose another to whom the Owner or Architect has no reasonable objection. If the proposed but rejected Subcontractor was reasonably capable of performing the Work, the Contract Sum and Contract Time shall be increased or decreased by the difference, if any, occasioned by such change, and an appropriate Change Order shall be issued before commencement of the substitute Subcontractor's Work. However, no increase in the Contract Sum or Contract Time shall be allowed for such change unless the Contractor has acted promptly and responsively in submitting names as required.

§ 5.2.4 The Contractor shall not substitute a Subcontractor, person, or entity for one previously selected if the Owner or Architect makes reasonable objection to such substitution.

§ 5.3 Subcontractual Relations

By appropriate written agreement, the Contractor shall require each Subcontractor, to the extent of the Work to be performed by the Subcontractor, to be bound to the Contractor by terms of the Contract Documents, and to assume toward the Contractor all the obligations and responsibilities, including the responsibility for safety of the Subcontractor's Work that the Contractor, by these Contract Documents, assumes toward the Owner and Architect. Each subcontract agreement shall preserve and protect the rights of the Owner and Architect under the Contract Documents with respect to the Work to be performed by the Subcontractor so that subcontracting thereof will not prejudice such rights, and shall allow to the Subcontractor, unless specifically provided otherwise in the subcontract agreement, the benefit of all rights, remedies, and redress against the Contractor that the Contractor, by the Contract Documents, has against the Owner. Where appropriate, the Contractor shall require each Subcontractor to enter into similar agreements with Sub-subcontractors. The Contractor shall make available to each proposed Subcontractor, prior to the execution of the subcontract agreement, copies of the Contract Documents to which the Subcontractor will be bound, and, upon written request of the Subcontractor, identify to the Subcontractor terms and conditions of the proposed subcontract agreement that may be at variance with the Contract Documents. Subcontractors will similarly make copies of applicable portions of such documents available to their respective proposed Sub-subcontractors.

§ 5.4 Contingent Assignment of Subcontracts

§ 5.4.1 Each subcontract agreement for a portion of the Work is assigned by the Contractor to the Owner, provided that

- **.1** assignment is effective only after termination of the Contract by the Owner for cause pursuant to Section 14.2 and only for those subcontract agreements that the Owner accepts by notifying the Subcontractor and Contractor; and
- **.2** assignment is subject to the prior rights of the surety, if any, obligated under bond relating to the Contract.

When the Owner accepts the assignment of a subcontract agreement, the Owner assumes the Contractor's rights and obligations under the subcontract.

§ 5.4.2 Upon such assignment, if the Work has been suspended for more than 30 days, the Subcontractor's compensation shall be equitably adjusted for increases in cost resulting from the suspension.

§ 5.4.3 Upon assignment to the Owner under this Section 5.4, the Owner may further assign the subcontract to a successor contractor or other entity. If the Owner assigns the subcontract to a successor contractor or other entity, the Owner shall nevertheless remain legally responsible for all of the successor contractor's obligations under the subcontract.

ARTICLE 6 CONSTRUCTION BY OWNER OR BY SEPARATE CONTRACTORS

§ 6.1 Owner's Right to Perform Construction and to Award Separate Contracts

§ 6.1.1 The term "Separate Contractor(s)" shall mean other contractors retained by the Owner under separate agreements. The Owner reserves the right to perform construction or operations related to the Project with the Owner's own forces, and with Separate Contractors retained under Conditions of the Contract substantially similar to those of this Contract, including those provisions of the Conditions of the Contract related to insurance and waiver of subrogation.

§ 6.1.2 When separate contracts are awarded for different portions of the Project or other construction or operations on the site, the term "Contractor" in the Contract Documents in each case shall mean the Contractor who executes each separate Owner-Contractor Agreement.

§ 6.1.3 The Owner shall provide for coordination of the activities of the Owner's own forces and of each Separate

Contractor with the Work of the Contractor, who shall cooperate with them. The Contractor shall participate with any Separate Contractors and the Owner in reviewing their construction schedules. The Contractor shall make any revisions to its construction schedule deemed necessary after a joint review and mutual agreement. The construction schedules shall then constitute the schedules to be used by the Contractor, Separate Contractors, and the Owner until subsequently revised.

§ 6.1.4 Unless otherwise provided in the Contract Documents, when the Owner performs construction or operations related to the Project with the Owner's own forces or with Separate Contractors, the Owner or its Separate Contractors shall have the same obligations and rights that the Contractor has under the Conditions of the Contract, including, without excluding others, those stated in Article 3, this Article 6, and Articles 10, 11, and 12.

§ 6.2 Mutual Responsibility

§ 6.2.1 The Contractor shall afford the Owner and Separate Contractors reasonable opportunity for introduction and storage of their materials and equipment and performance of their activities, and shall connect and coordinate the Contractor's construction and operations with theirs as required by the Contract Documents.

§ 6.2.2 If part of the Contractor's Work depends for proper execution or results upon construction or operations by the Owner or a Separate Contractor, the Contractor shall, prior to proceeding with that portion of the Work, promptly notify the Architect of apparent discrepancies or defects in the construction or operations by the Owner or Separate Contractor that would render it unsuitable for proper execution and results of the Contractor's Work. Failure of the Contractor to notify the Architect of apparent discrepancies or defects prior to proceeding with the Work shall constitute an acknowledgment that the Owner's or Separate Contractor's completed or partially completed construction is fit and proper to receive the Contractor's Work. The Contractor shall not be responsible for discrepancies or defects in the construction or operations by the Owner or Separate Contractor that are not apparent.

§ 6.2.3 The Contractor shall reimburse the Owner for costs the Owner incurs that are payable to a Separate Contractor because of the Contractor's delays, improperly timed activities or defective construction. The Owner shall be responsible to the Contractor for costs the Contractor incurs because of a Separate Contractor's delays, improperly timed activities, damage to the Work or defective construction.

§ 6.2.4 The Contractor shall promptly remedy damage that the Contractor wrongfully causes to completed or partially completed construction or to property of the Owner or Separate Contractor as provided in Section 10.2.5.

§ 6.2.5 The Owner and each Separate Contractor shall have the same responsibilities for cutting and patching as are described for the Contractor in Section 3.14.

§ 6.3 Owner's Right to Clean Up

If a dispute arises among the Contractor, Separate Contractors, and the Owner as to the responsibility under their respective contracts for maintaining the premises and surrounding area free from waste materials and rubbish, the Owner may clean up and the Architect will allocate the cost among those responsible.

ARTICLE 7 CHANGES IN THE WORK

§ 7.1 General

§ 7.1.1 Changes in the Work may be accomplished after execution of the Contract, and without invalidating the Contract, by Change Order, Construction Change Directive or order for a minor change in the Work, subject to the limitations stated in this Article 7 and elsewhere in the Contract Documents.

§ 7.1.2 A Change Order shall be based upon agreement among the Owner, Contractor, and Architect. A Construction Change Directive requires agreement by the Owner and Architect and may or may not be agreed to by the Contractor. An order for a minor change in the Work may be issued by the Architect alone.

§ 7.1.3 Changes in the Work shall be performed under applicable provisions of the Contract Documents. The Contractor shall proceed promptly with changes in the Work, unless otherwise provided in the Change Order, Construction Change Directive, or order for a minor change in the Work.

§ 7.2 Change Orders

§ 7.2.1 A Change Order is a written instrument prepared by the Architect and signed by the Owner, Contractor, and Architect stating their agreement upon all of the following:

.1 The change in the Work;
.2 The amount of the adjustment, if any, in the Contract Sum; and
.3 The extent of the adjustment, if any, in the Contract Time.

§ 7.3 Construction Change Directives

§ 7.3.1 A Construction Change Directive is a written order prepared by the Architect and signed by the Owner and Architect, directing a change in the Work prior to agreement on adjustment, if any, in the Contract Sum or Contract Time, or both. The Owner may by Construction Change Directive, without invalidating the Contract, order changes in the Work within the general scope of the Contract consisting of additions, deletions, or other revisions, the Contract Sum and Contract Time being adjusted accordingly.

§ 7.3.2 A Construction Change Directive shall be used in the absence of total agreement on the terms of a Change Order.

§ 7.3.3 If the Construction Change Directive provides for an adjustment to the Contract Sum, the adjustment shall be based on one of the following methods:

.1 Mutual acceptance of a lump sum properly itemized and supported by sufficient substantiating data to permit evaluation;
.2 Unit prices stated in the Contract Documents or subsequently agreed upon;
.3 Cost to be determined in a manner agreed upon by the parties and a mutually acceptable fixed or percentage fee; or
.4 As provided in Section 7.3.4.

§ 7.3.4 If the Contractor does not respond promptly or disagrees with the method for adjustment in the Contract Sum, the Architect shall determine the adjustment on the basis of reasonable expenditures and savings of those performing the Work attributable to the change, including, in case of an increase in the Contract Sum, an amount for overhead and profit as set forth in the Agreement, or if no such amount is set forth in the Agreement, a reasonable amount. In such case, and also under Section 7.3.3.3, the Contractor shall keep and present, in such form as the Architect may prescribe, an itemized accounting together with appropriate supporting data. Unless otherwise provided in the Contract Documents, costs for the purposes of this Section 7.3.4 shall be limited to the following:

.1 Costs of labor, including applicable payroll taxes, fringe benefits required by agreement or custom, workers' compensation insurance, and other employee costs approved by the Architect;
.2 Costs of materials, supplies, and equipment, including cost of transportation, whether incorporated or consumed;
.3 Rental costs of machinery and equipment, exclusive of hand tools, whether rented from the Contractor or others;
.4 Costs of premiums for all bonds and insurance, permit fees, and sales, use, or similar taxes, directly related to the change; and
.5 Costs of supervision and field office personnel directly attributable to the change.

§ 7.3.5 If the Contractor disagrees with the adjustment in the Contract Time, the Contractor may make a Claim in accordance with applicable provisions of Article 15.

§ 7.3.6 Upon receipt of a Construction Change Directive, the Contractor shall promptly proceed with the change in the Work involved and advise the Architect of the Contractor's agreement or disagreement with the method, if any, provided in the Construction Change Directive for determining the proposed adjustment in the Contract Sum or Contract Time.

§ 7.3.7 A Construction Change Directive signed by the Contractor indicates the Contractor's agreement therewith, including adjustment in Contract Sum and Contract Time or the method for determining them. Such agreement shall be effective immediately and shall be recorded as a Change Order.

§ 7.3.8 The amount of credit to be allowed by the Contractor to the Owner for a deletion or change that results in a net decrease in the Contract Sum shall be actual net cost as confirmed by the Architect. When both additions and credits covering related Work or substitutions are involved in a change, the allowance for overhead and profit shall be figured on the basis of net increase, if any, with respect to that change.

§ 7.3.9 Pending final determination of the total cost of a Construction Change Directive to the Owner, the Contractor may request payment for Work completed under the Construction Change Directive in Applications for Payment. The

Architect will make an interim determination for purposes of monthly certification for payment for those costs and certify for payment the amount that the Architect determines, in the Architect's professional judgment, to be reasonably justified. The Architect's interim determination of cost shall adjust the Contract Sum on the same basis as a Change Order, subject to the right of either party to disagree and assert a Claim in accordance with Article 15.

§ 7.3.10 When the Owner and Contractor agree with a determination made by the Architect concerning the adjustments in the Contract Sum and Contract Time, or otherwise reach agreement upon the adjustments, such agreement shall be effective immediately and the Architect will prepare a Change Order. Change Orders may be issued for all or any part of a Construction Change Directive.

§ 7.4 Minor Changes in the Work

The Architect may order minor changes in the Work that are consistent with the intent of the Contract Documents and do not involve an adjustment in the Contract Sum or an extension of the Contract Time. The Architect's order for minor changes shall be in writing. If the Contractor believes that the proposed minor change in the Work will affect the Contract Sum or Contract Time, the Contractor shall notify the Architect and shall not proceed to implement the change in the Work. If the Contractor performs the Work set forth in the Architect's order for a minor change without prior notice to the Architect that such change will affect the Contract Sum or Contract Time, the Contractor waives any adjustment to the Contract Sum or extension of the Contract Time.

ARTICLE 8 TIME

§ 8.1 Definitions

§ 8.1.1 Unless otherwise provided, Contract Time is the period of time, including authorized adjustments, allotted in the Contract Documents for Substantial Completion of the Work.

§ 8.1.2 The date of commencement of the Work is the date established in the Agreement.

§ 8.1.3 The date of Substantial Completion is the date certified by the Architect in accordance with Section 9.8.

§ 8.1.4 The term "day" as used in the Contract Documents shall mean calendar day unless otherwise specifically defined.

§ 8.2 Progress and Completion

§ 8.2.1 Time limits stated in the Contract Documents are of the essence of the Contract. By executing the Agreement, the Contractor confirms that the Contract Time is a reasonable period for performing the Work.

§ 8.2.2 The Contractor shall not knowingly, except by agreement or instruction of the Owner in writing, commence the Work prior to the effective date of insurance required to be furnished by the Contractor and Owner.

§ 8.2.3 The Contractor shall proceed expeditiously with adequate forces and shall achieve Substantial Completion within the Contract Time.

§ 8.3 Delays and Extensions of Time

§ 8.3.1 If the Contractor is delayed at any time in the commencement or progress of the Work by (1) an act or neglect of the Owner or Architect, of an employee of either, or of a Separate Contractor; (2) by changes ordered in the Work; (3) by labor disputes, fire, unusual delay in deliveries, unavoidable casualties, adverse weather conditions documented in accordance with Section 15.1.6.2, or other causes beyond the Contractor's control; (4) by delay authorized by the Owner pending mediation and binding dispute resolution; or (5) by other causes that the Contractor asserts, and the Architect determines, justify delay, then the Contract Time shall be extended for such reasonable time as the Architect may determine.

§ 8.3.2 Claims relating to time shall be made in accordance with applicable provisions of Article 15.

§ 8.3.3 This Section 8.3 does not preclude recovery of damages for delay by either party under other provisions of the Contract Documents.

ARTICLE 9 PAYMENTS AND COMPLETION

§ 9.1 Contract Sum

§ 9.1.1 The Contract Sum is stated in the Agreement and, including authorized adjustments, is the total amount payable

by the Owner to the Contractor for performance of the Work under the Contract Documents.

§ 9.1.2 If unit prices are stated in the Contract Documents or subsequently agreed upon, and if quantities originally contemplated are materially changed so that application of such unit prices to the actual quantities causes substantial inequity to the Owner or Contractor, the applicable unit prices shall be equitably adjusted.

§ 9.2 Schedule of Values

Where the Contract is based on a stipulated sum or Guaranteed Maximum Price, the Contractor shall submit a schedule of values to the Architect before the first Application for Payment, allocating the entire Contract Sum to the various portions of the Work. The schedule of values shall be prepared in the form, and supported by the data to substantiate its accuracy, required by the Architect. This schedule, unless objected to by the Architect, shall be used as a basis for reviewing the Contractor's Applications for Payment. Any changes to the schedule of values shall be submitted to the Architect and supported by such data to substantiate its accuracy as the Architect may require, and unless objected to by the Architect, shall be used as a basis for reviewing the Contractor's subsequent Applications for Payment.

§ 9.3 Applications for Payment

§ 9.3.1 At least ten days before the date established for each progress payment, the Contractor shall submit to the Architect an itemized Application for Payment prepared in accordance with the schedule of values, if required under Section 9.2, for completed portions of the Work. The application shall be notarized, if required, and supported by all data substantiating the Contractor's right to payment that the Owner or Architect require, such as copies of requisitions, and releases and waivers of liens from Subcontractors and suppliers, and shall reflect retainage if provided for in the Contract Documents.

§ 9.3.1.1 As provided in Section 7.3.9, such applications may include requests for payment on account of changes in the Work that have been properly authorized by Construction Change Directives, or by interim determinations of the Architect, but not yet included in Change Orders.

§ 9.3.1.2 Applications for Payment shall not include requests for payment for portions of the Work for which the Contractor does not intend to pay a Subcontractor or supplier, unless such Work has been performed by others whom the Contractor intends to pay.

§ 9.3.2 Unless otherwise provided in the Contract Documents, payments shall be made on account of materials and equipment delivered and suitably stored at the site for subsequent incorporation in the Work. If approved in advance by the Owner, payment may similarly be made for materials and equipment suitably stored off the site at a location agreed upon in writing. Payment for materials and equipment stored on or off the site shall be conditioned upon compliance by the Contractor with procedures satisfactory to the Owner to establish the Owner's title to such materials and equipment or otherwise protect the Owner's interest, and shall include the costs of applicable insurance, storage, and transportation to the site, for such materials and equipment stored off the site.

§ 9.3.3 The Contractor warrants that title to all Work covered by an Application for Payment will pass to the Owner no later than the time of payment. The Contractor further warrants that upon submittal of an Application for Payment all Work for which Certificates for Payment have been previously issued and payments received from the Owner shall, to the best of the Contractor's knowledge, information, and belief, be free and clear of liens, claims, security interests, or encumbrances, in favor of the Contractor, Subcontractors, suppliers, or other persons or entities that provided labor, materials, and equipment relating to the Work.

§ 9.4 Certificates for Payment

§ 9.4.1 The Architect will, within seven days after receipt of the Contractor's Application for Payment, either (1) issue to the Owner a Certificate for Payment in the full amount of the Application for Payment, with a copy to the Contractor; or (2) issue to the Owner a Certificate for Payment for such amount as the Architect determines is properly due, and notify the Contractor and Owner of the Architect's reasons for withholding certification in part as provided in Section 9.5.1; or (3) withhold certification of the entire Application for Payment, and notify the Contractor and Owner of the Architect's reason for withholding certification in whole as provided in Section 9.5.1.

§ 9.4.2 The issuance of a Certificate for Payment will constitute a representation by the Architect to the Owner, based on the Architect's evaluation of the Work and the data in the Application for Payment, that, to the best of the Architect's knowledge, information, and belief, the Work has progressed to the point indicated, the quality of the Work is in accordance with the Contract Documents, and that the Contractor is entitled to payment in the amount certified. The

foregoing representations are subject to an evaluation of the Work for conformance with the Contract Documents upon Substantial Completion, to results of subsequent tests and inspections, to correction of minor deviations from the Contract Documents prior to completion, and to specific qualifications expressed by the Architect. However, the issuance of a Certificate for Payment will not be a representation that the Architect has (1) made exhaustive or continuous on-site inspections to check the quality or quantity of the Work; (2) reviewed construction means, methods, techniques, sequences, or procedures; (3) reviewed copies of requisitions received from Subcontractors and suppliers and other data requested by the Owner to substantiate the Contractor's right to payment; or (4) made examination to ascertain how or for what purpose the Contractor has used money previously paid on account of the Contract Sum.

§ 9.5 Decisions to Withhold Certification

§ 9.5.1 The Architect may withhold a Certificate for Payment in whole or in part, to the extent reasonably necessary to protect the Owner, if in the Architect's opinion the representations to the Owner required by Section 9.4.2 cannot be made. If the Architect is unable to certify payment in the amount of the Application, the Architect will notify the Contractor and Owner as provided in Section 9.4.1. If the Contractor and Architect cannot agree on a revised amount, the Architect will promptly issue a Certificate for Payment for the amount for which the Architect is able to make such representations to the Owner. The Architect may also withhold a Certificate for Payment or, because of subsequently discovered evidence, may nullify the whole or a part of a Certificate for Payment previously issued, to such extent as may be necessary in the Architect's opinion to protect the Owner from loss for which the Contractor is responsible, including loss resulting from acts and omissions described in Section 3.3.2, because of

- **.1** defective Work not remedied;
- **.2** third party claims filed or reasonable evidence indicating probable filing of such claims, unless security acceptable to the Owner is provided by the Contractor;
- **.3** failure of the Contractor to make payments properly to Subcontractors or suppliers for labor, materials or equipment;
- **.4** reasonable evidence that the Work cannot be completed for the unpaid balance of the Contract Sum;
- **.5** damage to the Owner or a Separate Contractor;
- **.6** reasonable evidence that the Work will not be completed within the Contract Time, and that the unpaid balance would not be adequate to cover actual or liquidated damages for the anticipated delay; or
- **.7** repeated failure to carry out the Work in accordance with the Contract Documents.

§ 9.5.2 When either party disputes the Architect's decision regarding a Certificate for Payment under Section 9.5.1, in whole or in part, that party may submit a Claim in accordance with Article 15.

§ 9.5.3 When the reasons for withholding certification are removed, certification will be made for amounts previously withheld.

§ 9.5.4 If the Architect withholds certification for payment under Section 9.5.1.3, the Owner may, at its sole option, issue joint checks to the Contractor and to any Subcontractor or supplier to whom the Contractor failed to make payment for Work properly performed or material or equipment suitably delivered. If the Owner makes payments by joint check, the Owner shall notify the Architect and the Contractor shall reflect such payment on its next Application for Payment.

§ 9.6 Progress Payments

§ 9.6.1 After the Architect has issued a Certificate for Payment, the Owner shall make payment in the manner and within the time provided in the Contract Documents, and shall so notify the Architect.

§ 9.6.2 The Contractor shall pay each Subcontractor, no later than seven days after receipt of payment from the Owner, the amount to which the Subcontractor is entitled, reflecting percentages actually retained from payments to the Contractor on account of the Subcontractor's portion of the Work. The Contractor shall, by appropriate agreement with each Subcontractor, require each Subcontractor to make payments to Sub-subcontractors in a similar manner.

§ 9.6.3 The Architect will, on request, furnish to a Subcontractor, if practicable, information regarding percentages of completion or amounts applied for by the Contractor and action taken thereon by the Architect and Owner on account of portions of the Work done by such Subcontractor.

§ 9.6.4 The Owner has the right to request written evidence from the Contractor that the Contractor has properly paid Subcontractors and suppliers amounts paid by the Owner to the Contractor for subcontracted Work. If the Contractor fails to furnish such evidence within seven days, the Owner shall have the right to contact Subcontractors and suppliers

to ascertain whether they have been properly paid. Neither the Owner nor Architect shall have an obligation to pay, or to see to the payment of money to, a Subcontractor or supplier, except as may otherwise be required by law.

§ 9.6.5 The Contractor's payments to suppliers shall be treated in a manner similar to that provided in Sections 9.6.2, 9.6.3 and 9.6.4.

§ 9.6.6 A Certificate for Payment, a progress payment, or partial or entire use or occupancy of the Project by the Owner shall not constitute acceptance of Work not in accordance with the Contract Documents.

§ 9.6.7 Unless the Contractor provides the Owner with a payment bond in the full penal sum of the Contract Sum, payments received by the Contractor for Work properly performed by Subcontractors or provided by suppliers shall be held by the Contractor for those Subcontractors or suppliers who performed Work or furnished materials, or both, under contract with the Contractor for which payment was made by the Owner. Nothing contained herein shall require money to be placed in a separate account and not commingled with money of the Contractor, create any fiduciary liability or tort liability on the part of the Contractor for breach of trust, or entitle any person or entity to an award of punitive damages against the Contractor for breach of the requirements of this provision.

§ 9.6.8 Provided the Owner has fulfilled its payment obligations under the Contract Documents, the Contractor shall defend and indemnify the Owner from all loss, liability, damage or expense, including reasonable attorney's fees and litigation expenses, arising out of any lien claim or other claim for payment by any Subcontractor or supplier of any tier. Upon receipt of notice of a lien claim or other claim for payment, the Owner shall notify the Contractor. If approved by the applicable court, when required, the Contractor may substitute a surety bond for the property against which the lien or other claim for payment has been asserted.

§ 9.7 Failure of Payment

If the Architect does not issue a Certificate for Payment, through no fault of the Contractor, within seven days after receipt of the Contractor's Application for Payment, or if the Owner does not pay the Contractor within seven days after the date established in the Contract Documents, the amount certified by the Architect or awarded by binding dispute resolution, then the Contractor may, upon seven additional days' notice to the Owner and Architect, stop the Work until payment of the amount owing has been received. The Contract Time shall be extended appropriately and the Contract Sum shall be increased by the amount of the Contractor's reasonable costs of shutdown, delay and start-up, plus interest as provided for in the Contract Documents.

§ 9.8 Substantial Completion

§ 9.8.1 Substantial Completion is the stage in the progress of the Work when the Work or designated portion thereof is sufficiently complete in accordance with the Contract Documents so that the Owner can occupy or utilize the Work for its intended use.

§ 9.8.2 When the Contractor considers that the Work, or a portion thereof which the Owner agrees to accept separately, is substantially complete, the Contractor shall prepare and submit to the Architect a comprehensive list of items to be completed or corrected prior to final payment. Failure to include an item on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.

§ 9.8.3 Upon receipt of the Contractor's list, the Architect will make an inspection to determine whether the Work or designated portion thereof is substantially complete. If the Architect's inspection discloses any item, whether or not included on the Contractor's list, which is not sufficiently complete in accordance with the Contract Documents so that the Owner can occupy or utilize the Work or designated portion thereof for its intended use, the Contractor shall, before issuance of the Certificate of Substantial Completion, complete or correct such item upon notification by the Architect. In such case, the Contractor shall then submit a request for another inspection by the Architect to determine Substantial Completion.

§ 9.8.4 When the Work or designated portion thereof is substantially complete, the Architect will prepare a Certificate of Substantial Completion that shall establish the date of Substantial Completion; establish responsibilities of the Owner and Contractor for security, maintenance, heat, utilities, damage to the Work and insurance; and fix the time within which the Contractor shall finish all items on the list accompanying the Certificate. Warranties required by the Contract Documents shall commence on the date of Substantial Completion of the Work or designated portion thereof unless otherwise provided in the Certificate of Substantial Completion.

§ 9.8.5 The Certificate of Substantial Completion shall be submitted to the Owner and Contractor for their written acceptance of responsibilities assigned to them in the Certificate. Upon such acceptance, and consent of surety if any, the Owner shall make payment of retainage applying to the Work or designated portion thereof. Such payment shall be adjusted for Work that is incomplete or not in accordance with the requirements of the Contract Documents.

§ 9.9 Partial Occupancy or Use

§ 9.9.1 The Owner may occupy or use any completed or partially completed portion of the Work at any stage when such portion is designated by separate agreement with the Contractor, provided such occupancy or use is consented to by the insurer and authorized by public authorities having jurisdiction over the Project. Such partial occupancy or use may commence whether or not the portion is substantially complete, provided the Owner and Contractor have accepted in writing the responsibilities assigned to each of them for payments, retainage, if any, security, maintenance, heat, utilities, damage to the Work and insurance, and have agreed in writing concerning the period for correction of the Work and commencement of warranties required by the Contract Documents. When the Contractor considers a portion substantially complete, the Contractor shall prepare and submit a list to the Architect as provided under Section 9.8.2. Consent of the Contractor to partial occupancy or use shall not be unreasonably withheld. The stage of the progress of the Work shall be determined by written agreement between the Owner and Contractor or, if no agreement is reached, by decision of the Architect.

§ 9.9.2 Immediately prior to such partial occupancy or use, the Owner, Contractor, and Architect shall jointly inspect the area to be occupied or portion of the Work to be used in order to determine and record the condition of the Work.

§ 9.9.3 Unless otherwise agreed upon, partial occupancy or use of a portion or portions of the Work shall not constitute acceptance of Work not complying with the requirements of the Contract Documents.

§ 9.10 Final Completion and Final Payment

§ 9.10.1 Upon receipt of the Contractor's notice that the Work is ready for final inspection and acceptance and upon receipt of a final Application for Payment, the Architect will promptly make such inspection. When the Architect finds the Work acceptable under the Contract Documents and the Contract fully performed, the Architect will promptly issue a final Certificate for Payment stating that to the best of the Architect's knowledge, information and belief, and on the basis of the Architect's on-site visits and inspections, the Work has been completed in accordance with the Contract Documents and that the entire balance found to be due the Contractor and noted in the final Certificate is due and payable. The Architect's final Certificate for Payment will constitute a further representation that conditions listed in Section 9.10.2 as precedent to the Contractor's being entitled to final payment have been fulfilled.

§ 9.10.2 Neither final payment nor any remaining retained percentage shall become due until the Contractor submits to the Architect (1) an affidavit that payrolls, bills for materials and equipment, and other indebtedness connected with the Work for which the Owner or the Owner's property might be responsible or encumbered (less amounts withheld by Owner) have been paid or otherwise satisfied, (2) a certificate evidencing that insurance required by the Contract Documents to remain in force after final payment is currently in effect, (3) a written statement that the Contractor knows of no reason that the insurance will not be renewable to cover the period required by the Contract Documents, (4) consent of surety, if any, to final payment, (5) documentation of any special warranties, such as manufacturers' warranties or specific Subcontractor warranties, and (6) if required by the Owner, other data establishing payment or satisfaction of obligations, such as receipts and releases and waivers of liens, claims, security interests, or encumbrances arising out of the Contract, to the extent and in such form as may be designated by the Owner. If a Subcontractor refuses to furnish a release or waiver required by the Owner, the Contractor may furnish a bond satisfactory to the Owner to indemnify the Owner against such lien, claim, security interest, or encumbrance. If a lien, claim, security interest, or encumbrance remains unsatisfied after payments are made, the Contractor shall refund to the Owner all money that the Owner may be compelled to pay in discharging the lien, claim, security interest, or encumbrance, including all costs and reasonable attorneys' fees.

§ 9.10.3 If, after Substantial Completion of the Work, final completion thereof is materially delayed through no fault of the Contractor or by issuance of Change Orders affecting final completion, and the Architect so confirms, the Owner shall, upon application by the Contractor and certification by the Architect, and without terminating the Contract, make payment of the balance due for that portion of the Work fully completed, corrected, and accepted. If the remaining balance for Work not fully completed or corrected is less than retainage stipulated in the Contract Documents, and if bonds have been furnished, the written consent of the surety to payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by the Contractor to the Architect prior to certification of such payment. Such payment shall be made under terms and conditions governing final payment, except that it shall not

constitute a waiver of Claims.

§ 9.10.4 The making of final payment shall constitute a waiver of Claims by the Owner except those arising from

- **.1** liens, Claims, security interests, or encumbrances arising out of the Contract and unsettled;
- **.2** failure of the Work to comply with the requirements of the Contract Documents;
- **.3** terms of special warranties required by the Contract Documents; or
- **.4** audits performed by the Owner, if permitted by the Contract Documents, after final payment.

§ 9.10.5 Acceptance of final payment by the Contractor, a Subcontractor, or a supplier, shall constitute a waiver of claims by that payee except those previously made in writing and identified by that payee as unsettled at the time of final Application for Payment.

ARTICLE 10 PROTECTION OF PERSONS AND PROPERTY

§ 10.1 Safety Precautions and Programs

The Contractor shall be responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the performance of the Contract.

§ 10.2 Safety of Persons and Property

§ 10.2.1 The Contractor shall take reasonable precautions for safety of, and shall provide reasonable protection to prevent damage, injury, or loss to

- **.1** employees on the Work and other persons who may be affected thereby;
- **.2** the Work and materials and equipment to be incorporated therein, whether in storage on or off the site, under care, custody, or control of the Contractor, a Subcontractor, or a Sub-subcontractor; and
- **.3** other property at the site or adjacent thereto, such as trees, shrubs, lawns, walks, pavements, roadways, structures, and utilities not designated for removal, relocation, or replacement in the course of construction.

§ 10.2.2 The Contractor shall comply with, and give notices required by applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities, bearing on safety of persons or property or their protection from damage, injury, or loss.

§ 10.2.3 The Contractor shall implement, erect, and maintain, as required by existing conditions and performance of the Contract, reasonable safeguards for safety and protection, including posting danger signs and other warnings against hazards; promulgating safety regulations; and notifying the owners and users of adjacent sites and utilities of the safeguards.

§ 10.2.4 When use or storage of explosives or other hazardous materials or equipment, or unusual methods are necessary for execution of the Work, the Contractor shall exercise utmost care and carry on such activities under supervision of properly qualified personnel.

§ 10.2.5 The Contractor shall promptly remedy damage and loss (other than damage or loss insured under property insurance required by the Contract Documents) to property referred to in Sections 10.2.1.2 and 10.2.1.3 caused in whole or in part by the Contractor, a Subcontractor, a Sub-subcontractor, or anyone directly or indirectly employed by any of them, or by anyone for whose acts they may be liable and for which the Contractor is responsible under Sections 10.2.1.2 and 10.2.1.3. The Contractor may make a Claim for the cost to remedy the damage or loss to the extent such damage or loss is attributable to acts or omissions of the Owner or Architect or anyone directly or indirectly employed by either of them, or by anyone for whose acts either of them may be liable, and not attributable to the fault or negligence of the Contractor. The foregoing obligations of the Contractor are in addition to the Contractor's obligations under Section 3.18.

§ 10.2.6 The Contractor shall designate a responsible member of the Contractor's organization at the site whose duty shall be the prevention of accidents. This person shall be the Contractor's superintendent unless otherwise designated by the Contractor in writing to the Owner and Architect.

§ 10.2.7 The Contractor shall not permit any part of the construction or site to be loaded so as to cause damage or create an unsafe condition.

§ 10.2.8 Injury or Damage to Person or Property
If either party suffers injury or damage to person or property because of an act or omission of the other party, or of others for whose acts such party is legally responsible, notice of the injury or damage, whether or not insured, shall be given to the other party within a reasonable time not exceeding 21 days after discovery. The notice shall provide sufficient detail to enable the other party to investigate the matter.

§ 10.3 Hazardous Materials and Substances
§ 10.3.1 The Contractor is responsible for compliance with any requirements included in the Contract Documents regarding hazardous materials or substances. If the Contractor encounters a hazardous material or substance not addressed in the Contract Documents and if reasonable precautions will be inadequate to prevent foreseeable bodily injury or death to persons resulting from a material or substance, including but not limited to asbestos or polychlorinated biphenyl (PCB), encountered on the site by the Contractor, the Contractor shall, upon recognizing the condition, immediately stop Work in the affected area and notify the Owner and Architect of the condition.

§ 10.3.2 Upon receipt of the Contractor's notice, the Owner shall obtain the services of a licensed laboratory to verify the presence or absence of the material or substance reported by the Contractor and, in the event such material or substance is found to be present, to cause it to be rendered harmless. Unless otherwise required by the Contract Documents, the Owner shall furnish in writing to the Contractor and Architect the names and qualifications of persons or entities who are to perform tests verifying the presence or absence of the material or substance or who are to perform the task of removal or safe containment of the material or substance. The Contractor and the Architect will promptly reply to the Owner in writing stating whether or not either has reasonable objection to the persons or entities proposed by the Owner. If either the Contractor or Architect has an objection to a person or entity proposed by the Owner, the Owner shall propose another to whom the Contractor and the Architect have no reasonable objection. When the material or substance has been rendered harmless, Work in the affected area shall resume upon written agreement of the Owner and Contractor. By Change Order, the Contract Time shall be extended appropriately and the Contract Sum shall be increased by the amount of the Contractor's reasonable additional costs of shutdown, delay, and start-up.

§ 10.3.3 To the fullest extent permitted by law, the Owner shall indemnify and hold harmless the Contractor, Subcontractors, Architect, Architect's consultants, and agents and employees of any of them from and against claims, damages, losses, and expenses, including but not limited to attorneys' fees, arising out of or resulting from performance of the Work in the affected area if in fact the material or substance presents the risk of bodily injury or death as described in Section 10.3.1 and has not been rendered harmless, provided that such claim, damage, loss, or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself), except to the extent that such damage, loss, or expense is due to the fault or negligence of the party seeking indemnity.

§ 10.3.4 The Owner shall not be responsible under this Section 10.3 for hazardous materials or substances the Contractor brings to the site unless such materials or substances are required by the Contract Documents. The Owner shall be responsible for hazardous materials or substances required by the Contract Documents, except to the extent of the Contractor's fault or negligence in the use and handling of such materials or substances.

§ 10.3.5 The Contractor shall reimburse the Owner for the cost and expense the Owner incurs (1) for remediation of hazardous materials or substances the Contractor brings to the site and negligently handles, or (2) where the Contractor fails to perform its obligations under Section 10.3.1, except to the extent that the cost and expense are due to the Owner's fault or negligence.

§ 10.3.6 If, without negligence on the part of the Contractor, the Contractor is held liable by a government agency for the cost of remediation of a hazardous material or substance solely by reason of performing Work as required by the Contract Documents, the Owner shall reimburse the Contractor for all cost and expense thereby incurred.

§ 10.4 Emergencies
In an emergency affecting safety of persons or property, the Contractor shall act, at the Contractor's discretion, to prevent threatened damage, injury, or loss. Additional compensation or extension of time claimed by the Contractor on account of an emergency shall be determined as provided in Article 15 and Article 7.

ARTICLE 11 INSURANCE AND BONDS
§ 11.1 Contractor's Insurance and Bonds
§ 11.1.1 The Contractor shall purchase and maintain insurance of the types and limits of liability, containing the

endorsements, and subject to the terms and conditions, as described in the Agreement or elsewhere in the Contract Documents. The Contractor shall purchase and maintain the required insurance from an insurance company or insurance companies lawfully authorized to issue insurance in the jurisdiction where the Project is located. The Owner, Architect, and Architect's consultants shall be named as additional insureds under the Contractor's commercial general liability policy or as otherwise described in the Contract Documents.

§ 11.1.2 The Contractor shall provide surety bonds of the types, for such penal sums, and subject to such terms and conditions as required by the Contract Documents. The Contractor shall purchase and maintain the required bonds from a company or companies lawfully authorized to issue surety bonds in the jurisdiction where the Project is located.

§ 11.1.3 Upon the request of any person or entity appearing to be a potential beneficiary of bonds covering payment of obligations arising under the Contract, the Contractor shall promptly furnish a copy of the bonds or shall authorize a copy to be furnished.

§ 11.1.4 Notice of Cancellation or Expiration of Contractor's Required Insurance. Within three (3) business days of the date the Contractor becomes aware of an impending or actual cancellation or expiration of any insurance required by the Contract Documents, the Contractor shall provide notice to the Owner of such impending or actual cancellation or expiration. Upon receipt of notice from the Contractor, the Owner shall, unless the lapse in coverage arises from an act or omission of the Owner, have the right to stop the Work until the lapse in coverage has been cured by the procurement of replacement coverage by the Contractor. The furnishing of notice by the Contractor shall not relieve the Contractor of any contractual obligation to provide any required coverage.

§ 11.2 Owner's Insurance

§ 11.2.1 The Owner shall purchase and maintain insurance of the types and limits of liability, containing the endorsements, and subject to the terms and conditions, as described in the Agreement or elsewhere in the Contract Documents. The Owner shall purchase and maintain the required insurance from an insurance company or insurance companies lawfully authorized to issue insurance in the jurisdiction where the Project is located.

§ 11.2.2 Failure to Purchase Required Property Insurance. If the Owner fails to purchase and maintain the required property insurance, with all of the coverages and in the amounts described in the Agreement or elsewhere in the Contract Documents, the Owner shall inform the Contractor in writing prior to commencement of the Work. Upon receipt of notice from the Owner, the Contractor may delay commencement of the Work and may obtain insurance that will protect the interests of the Contractor, Subcontractors, and Sub-Subcontractors in the Work. When the failure to provide coverage has been cured or resolved, the Contract Sum and Contract Time shall be equitably adjusted. In the event the Owner fails to procure coverage, the Owner waives all rights against the Contractor, Subcontractors, and Sub-subcontractors to the extent the loss to the Owner would have been covered by the insurance to have been procured by the Owner. The cost of the insurance shall be charged to the Owner by a Change Order. If the Owner does not provide written notice, and the Contractor is damaged by the failure or neglect of the Owner to purchase or maintain the required insurance, the Owner shall reimburse the Contractor for all reasonable costs and damages attributable thereto.

§ 11.2.3 Notice of Cancellation or Expiration of Owner's Required Property Insurance. Within three (3) business days of the date the Owner becomes aware of an impending or actual cancellation or expiration of any property insurance required by the Contract Documents, the Owner shall provide notice to the Contractor of such impending or actual cancellation or expiration. Unless the lapse in coverage arises from an act or omission of the Contractor: (1) the Contractor, upon receipt of notice from the Owner, shall have the right to stop the Work until the lapse in coverage has been cured by the procurement of replacement coverage by either the Owner or the Contractor; (2) the Contract Time and Contract Sum shall be equitably adjusted; and (3) the Owner waives all rights against the Contractor, Subcontractors, and Sub-subcontractors to the extent any loss to the Owner would have been covered by the insurance had it not expired or been cancelled. If the Contractor purchases replacement coverage, the cost of the insurance shall be charged to the Owner by an appropriate Change Order. The furnishing of notice by the Owner shall not relieve the Owner of any contractual obligation to provide required insurance.

§ 11.3 Waivers of Subrogation

§ 11.3.1 The Owner and Contractor waive all rights against (1) each other and any of their subcontractors, sub-subcontractors, agents, and employees, each of the other; (2) the Architect and Architect's consultants; and (3) Separate Contractors, if any, and any of their subcontractors, sub-subcontractors, agents, and employees, for damages caused by fire, or other causes of loss, to the extent those losses are covered by property insurance required by the Agreement or other property insurance applicable to the Project, except such rights as they have to proceeds of such insurance. The

Owner or Contractor, as appropriate, shall require similar written waivers in favor of the individuals and entities identified above from the Architect, Architect's consultants, Separate Contractors, subcontractors, and sub-subcontractors. The policies of insurance purchased and maintained by each person or entity agreeing to waive claims pursuant to this section 11.3.1 shall not prohibit this waiver of subrogation. This waiver of subrogation shall be effective as to a person or entity (1) even though that person or entity would otherwise have a duty of indemnification, contractual or otherwise, (2) even though that person or entity did not pay the insurance premium directly or indirectly, or (3) whether or not the person or entity had an insurable interest in the damaged property.

§ 11.3.2 If during the Project construction period the Owner insures properties, real or personal or both, at or adjacent to the site by property insurance under policies separate from those insuring the Project, or if after final payment property insurance is to be provided on the completed Project through a policy or policies other than those insuring the Project during the construction period, to the extent permissible by such policies, the Owner waives all rights in accordance with the terms of Section 11.3.1 for damages caused by fire or other causes of loss covered by this separate property insurance.

§ 11.4 Loss of Use, Business Interruption, and Delay in Completion Insurance

The Owner, at the Owner's option, may purchase and maintain insurance that will protect the Owner against loss of use of the Owner's property, or the inability to conduct normal operations, due to fire or other causes of loss. The Owner waives all rights of action against the Contractor and Architect for loss of use of the Owner's property, due to fire or other hazards however caused.

§11.5 Adjustment and Settlement of Insured Loss

§ 11.5.1 A loss insured under the property insurance required by the Agreement shall be adjusted by the Owner as fiduciary and made payable to the Owner as fiduciary for the insureds, as their interests may appear, subject to requirements of any applicable mortgagee clause and of Section 11.5.2. The Owner shall pay the Architect and Contractor their just shares of insurance proceeds received by the Owner, and by appropriate agreements the Architect and Contractor shall make payments to their consultants and Subcontractors in similar manner.

§ 11.5.2 Prior to settlement of an insured loss, the Owner shall notify the Contractor of the terms of the proposed settlement as well as the proposed allocation of the insurance proceeds. The Contractor shall have 14 days from receipt of notice to object to the proposed settlement or allocation of the proceeds. If the Contractor does not object, the Owner shall settle the loss and the Contractor shall be bound by the settlement and allocation. Upon receipt, the Owner shall deposit the insurance proceeds in a separate account and make the appropriate distributions. Thereafter, if no other agreement is made or the Owner does not terminate the Contract for convenience, the Owner and Contractor shall execute a Change Order for reconstruction of the damaged or destroyed Work in the amount allocated for that purpose. If the Contractor timely objects to either the terms of the proposed settlement or the allocation of the proceeds, the Owner may proceed to settle the insured loss, and any dispute between the Owner and Contractor arising out of the settlement or allocation of the proceeds shall be resolved pursuant to Article 15. Pending resolution of any dispute, the Owner may issue a Construction Change Directive for the reconstruction of the damaged or destroyed Work.

ARTICLE 12 UNCOVERING AND CORRECTION OF WORK

§ 12.1 Uncovering of Work

§ 12.1.1 If a portion of the Work is covered contrary to the Architect's request or to requirements specifically expressed in the Contract Documents, it must, if requested in writing by the Architect, be uncovered for the Architect's examination and be replaced at the Contractor's expense without change in the Contract Time.

§ 12.1.2 If a portion of the Work has been covered that the Architect has not specifically requested to examine prior to its being covered, the Architect may request to see such Work and it shall be uncovered by the Contractor. If such Work is in accordance with the Contract Documents, the Contractor shall be entitled to an equitable adjustment to the Contract Sum and Contract Time as may be appropriate. If such Work is not in accordance with the Contract Documents, the costs of uncovering the Work, and the cost of correction, shall be at the Contractor's expense.

§ 12.2 Correction of Work

§ 12.2.1 Before Substantial Completion

The Contractor shall promptly correct Work rejected by the Architect or failing to conform to the requirements of the Contract Documents, discovered before Substantial Completion and whether or not fabricated, installed or completed. Costs of correcting such rejected Work, including additional testing and inspections, the cost of uncovering and replacement, and compensation for the Architect's services and expenses made necessary thereby, shall be at the

Contractor's expense.

§ 12.2.2 After Substantial Completion

§ 12.2.2.1 In addition to the Contractor's obligations under Section 3.5, if, within one year after the date of Substantial Completion of the Work or designated portion thereof or after the date for commencement of warranties established under Section 9.9.1, or by terms of any applicable special warranty required by the Contract Documents, any of the Work is found to be not in accordance with the requirements of the Contract Documents, the Contractor shall correct it promptly after receipt of notice from the Owner to do so, unless the Owner has previously given the Contractor a written acceptance of such condition. The Owner shall give such notice promptly after discovery of the condition. During the one-year period for correction of Work, if the Owner fails to notify the Contractor and give the Contractor an opportunity to make the correction, the Owner waives the rights to require correction by the Contractor and to make a claim for breach of warranty. If the Contractor fails to correct nonconforming Work within a reasonable time during that period after receipt of notice from the Owner or Architect, the Owner may correct it in accordance with Section 2.5.

§ 12.2.2.2 The one-year period for correction of Work shall be extended with respect to portions of Work first performed after Substantial Completion by the period of time between Substantial Completion and the actual completion of that portion of the Work.

§ 12.2.2.3 The one-year period for correction of Work shall not be extended by corrective Work performed by the Contractor pursuant to this Section 12.2.

§ 12.2.3 The Contractor shall remove from the site portions of the Work that are not in accordance with the requirements of the Contract Documents and are neither corrected by the Contractor nor accepted by the Owner.

§ 12.2.4 The Contractor shall bear the cost of correcting destroyed or damaged construction of the Owner or Separate Contractors, whether completed or partially completed, caused by the Contractor's correction or removal of Work that is not in accordance with the requirements of the Contract Documents.

§ 12.2.5 Nothing contained in this Section 12.2 shall be construed to establish a period of limitation with respect to other obligations the Contractor has under the Contract Documents. Establishment of the one-year period for correction of Work as described in Section 12.2.2 relates only to the specific obligation of the Contractor to correct the Work, and has no relationship to the time within which the obligation to comply with the Contract Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish the Contractor's liability with respect to the Contractor's obligations other than specifically to correct the Work.

§ 12.3 Acceptance of Nonconforming Work

If the Owner prefers to accept Work that is not in accordance with the requirements of the Contract Documents, the Owner may do so instead of requiring its removal and correction, in which case the Contract Sum will be reduced as appropriate and equitable. Such adjustment shall be effected whether or not final payment has been made.

ARTICLE 13 MISCELLANEOUS PROVISIONS

§ 13.1 Governing Law

The Contract shall be governed by the law of the place where the Project is located, excluding that jurisdiction's choice of law rules. If the parties have selected arbitration as the method of binding dispute resolution, the Federal Arbitration Act shall govern Section 15.4.

§ 13.2 Successors and Assigns

§ 13.2.1 The Owner and Contractor respectively bind themselves, their partners, successors, assigns, and legal representatives to covenants, agreements, and obligations contained in the Contract Documents. Except as provided in Section 13.2.2, neither party to the Contract shall assign the Contract as a whole without written consent of the other. If either party attempts to make an assignment without such consent, that party shall nevertheless remain legally responsible for all obligations under the Contract.

§ 13.2.2 The Owner may, without consent of the Contractor, assign the Contract to a lender providing construction financing for the Project, if the lender assumes the Owner's rights and obligations under the Contract Documents. The Contractor shall execute all consents reasonably required to facilitate the assignment.

§ 13.3 Rights and Remedies

§ 13.3.1 Duties and obligations imposed by the Contract Documents and rights and remedies available thereunder shall be in addition to and not a limitation of duties, obligations, rights, and remedies otherwise imposed or available by law.

§ 13.3.2 No action or failure to act by the Owner, Architect, or Contractor shall constitute a waiver of a right or duty afforded them under the Contract, nor shall such action or failure to act constitute approval of or acquiescence in a breach thereunder, except as may be specifically agreed upon in writing.

§ 13.4 Tests and Inspections

§ 13.4.1 Tests, inspections, and approvals of portions of the Work shall be made as required by the Contract Documents and by applicable laws, statutes, ordinances, codes, rules, and regulations or lawful orders of public authorities. Unless otherwise provided, the Contractor shall make arrangements for such tests, inspections, and approvals with an independent testing laboratory or entity acceptable to the Owner, or with the appropriate public authority, and shall bear all related costs of tests, inspections, and approvals. The Contractor shall give the Architect timely notice of when and where tests and inspections are to be made so that the Architect may be present for such procedures. The Owner shall bear costs of tests, inspections, or approvals that do not become requirements until after bids are received or negotiations concluded. The Owner shall directly arrange and pay for tests, inspections, or approvals where building codes or applicable laws or regulations so require.

§ 13.4.2 If the Architect, Owner, or public authorities having jurisdiction determine that portions of the Work require additional testing, inspection, or approval not included under Section 13.4.1, the Architect will, upon written authorization from the Owner, instruct the Contractor to make arrangements for such additional testing, inspection, or approval, by an entity acceptable to the Owner, and the Contractor shall give timely notice to the Architect of when and where tests and inspections are to be made so that the Architect may be present for such procedures. Such costs, except as provided in Section 13.4.3, shall be at the Owner's expense.

§ 13.4.3 If procedures for testing, inspection, or approval under Sections 13.4.1 and 13.4.2 reveal failure of the portions of the Work to comply with requirements established by the Contract Documents, all costs made necessary by such failure, including those of repeated procedures and compensation for the Architect's services and expenses, shall be at the Contractor's expense.

§ 13.4.4 Required certificates of testing, inspection, or approval shall, unless otherwise required by the Contract Documents, be secured by the Contractor and promptly delivered to the Architect.

§ 13.4.5 If the Architect is to observe tests, inspections, or approvals required by the Contract Documents, the Architect will do so promptly and, where practicable, at the normal place of testing.

§ 13.4.6 Tests or inspections conducted pursuant to the Contract Documents shall be made promptly to avoid unreasonable delay in the Work.

§ 13.5 Interest

Payments due and unpaid under the Contract Documents shall bear interest from the date payment is due at the rate the parties agree upon in writing or, in the absence thereof, at the legal rate prevailing from time to time at the place where the Project is located.

ARTICLE 14 TERMINATION OR SUSPENSION OF THE CONTRACT

§ 14.1 Termination by the Contractor

§ 14.1.1 The Contractor may terminate the Contract if the Work is stopped for a period of 30 consecutive days through no act or fault of the Contractor, a Subcontractor, a Sub-subcontractor, their agents or employees, or any other persons or entities performing portions of the Work, for any of the following reasons:

- **.1** Issuance of an order of a court or other public authority having jurisdiction that requires all Work to be stopped;
- **.2** An act of government, such as a declaration of national emergency, that requires all Work to be stopped;
- **.3** Because the Architect has not issued a Certificate for Payment and has not notified the Contractor of the reason for withholding certification as provided in Section 9.4.1, or because the Owner has not made payment on a Certificate for Payment within the time stated in the Contract Documents; or
- **.4** The Owner has failed to furnish to the Contractor reasonable evidence as required by Section 2.2.

§ 14.1.2 The Contractor may terminate the Contract if, through no act or fault of the Contractor, a Subcontractor, a Sub-subcontractor, their agents or employees, or any other persons or entities performing portions of the Work, repeated suspensions, delays, or interruptions of the entire Work by the Owner as described in Section 14.3, constitute in the aggregate more than 100 percent of the total number of days scheduled for completion, or 120 days in any 365-day period, whichever is less.

§ 14.1.3 If one of the reasons described in Section 14.1.1 or 14.1.2 exists, the Contractor may, upon seven days' notice to the Owner and Architect, terminate the Contract and recover from the Owner payment for Work executed, as well as reasonable overhead and profit on Work not executed, and costs incurred by reason of such termination.

§ 14.1.4 If the Work is stopped for a period of 60 consecutive days through no act or fault of the Contractor, a Subcontractor, a Sub-subcontractor, or their agents or employees or any other persons or entities performing portions of the Work because the Owner has repeatedly failed to fulfill the Owner's obligations under the Contract Documents with respect to matters important to the progress of the Work, the Contractor may, upon seven additional days' notice to the Owner and the Architect, terminate the Contract and recover from the Owner as provided in Section 14.1.3.

§ 14.2 Termination by the Owner for Cause

§ 14.2.1 The Owner may terminate the Contract if the Contractor

- **.1** repeatedly refuses or fails to supply enough properly skilled workers or proper materials;
- **.2** fails to make payment to Subcontractors or suppliers in accordance with the respective agreements between the Contractor and the Subcontractors or suppliers;
- **.3** repeatedly disregards applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of a public authority; or
- **.4** otherwise is guilty of substantial breach of a provision of the Contract Documents.

§ 14.2.2 When any of the reasons described in Section 14.2.1 exist, and upon certification by the Architect that sufficient cause exists to justify such action, the Owner may, without prejudice to any other rights or remedies of the Owner and after giving the Contractor and the Contractor's surety, if any, seven days' notice, terminate employment of the Contractor and may, subject to any prior rights of the surety:

- **.1** Exclude the Contractor from the site and take possession of all materials, equipment, tools, and construction equipment and machinery thereon owned by the Contractor;
- **.2** Accept assignment of subcontracts pursuant to Section 5.4; and
- **.3** Finish the Work by whatever reasonable method the Owner may deem expedient. Upon written request of the Contractor, the Owner shall furnish to the Contractor a detailed accounting of the costs incurred by the Owner in finishing the Work.

§ 14.2.3 When the Owner terminates the Contract for one of the reasons stated in Section 14.2.1, the Contractor shall not be entitled to receive further payment until the Work is finished.

§ 14.2.4 If the unpaid balance of the Contract Sum exceeds costs of finishing the Work, including compensation for the Architect's services and expenses made necessary thereby, and other damages incurred by the Owner and not expressly waived, such excess shall be paid to the Contractor. If such costs and damages exceed the unpaid balance, the Contractor shall pay the difference to the Owner. The amount to be paid to the Contractor or Owner, as the case may be, shall be certified by the Initial Decision Maker, upon application, and this obligation for payment shall survive termination of the Contract.

§ 14.3 Suspension by the Owner for Convenience

§ 14.3.1 The Owner may, without cause, order the Contractor in writing to suspend, delay or interrupt the Work, in whole or in part for such period of time as the Owner may determine.

§ 14.3.2 The Contract Sum and Contract Time shall be adjusted for increases in the cost and time caused by suspension, delay, or interruption under Section 14.3.1. Adjustment of the Contract Sum shall include profit. No adjustment shall be made to the extent

- **.1** that performance is, was, or would have been, so suspended, delayed, or interrupted, by another cause for which the Contractor is responsible; or
- **.2** that an equitable adjustment is made or denied under another provision of the Contract.

§ 14.4 Termination by the Owner for Convenience

§ 14.4.1 The Owner may, at any time, terminate the Contract for the Owner's convenience and without cause.

§ 14.4.2 Upon receipt of notice from the Owner of such termination for the Owner's convenience, the Contractor shall

.1 cease operations as directed by the Owner in the notice;

.2 take actions necessary, or that the Owner may direct, for the protection and preservation of the Work; and

.3 except for Work directed to be performed prior to the effective date of termination stated in the notice, terminate all existing subcontracts and purchase orders and enter into no further subcontracts and purchase orders.

§ 14.4.3 In case of such termination for the Owner's convenience, the Owner shall pay the Contractor for Work properly executed; costs incurred by reason of the termination, including costs attributable to termination of Subcontracts; and the termination fee, if any, set forth in the Agreement.

ARTICLE 15 CLAIMS AND DISPUTES

§ 15.1 Claims

§ 15.1.1 Definition

A Claim is a demand or assertion by one of the parties seeking, as a matter of right, payment of money, a change in the Contract Time, or other relief with respect to the terms of the Contract. The term "Claim" also includes other disputes and matters in question between the Owner and Contractor arising out of or relating to the Contract. The responsibility to substantiate Claims shall rest with the party making the Claim. This Section 15.1.1 does not require the Owner to file a Claim in order to impose liquidated damages in accordance with the Contract Documents.

§ 15.1.2 Time Limits on Claims

The Owner and Contractor shall commence all Claims and causes of action against the other and arising out of or related to the Contract, whether in contract, tort, breach of warranty or otherwise, in accordance with the requirements of the binding dispute resolution method selected in the Agreement and within the period specified by applicable law, but in any case not more than 10 years after the date of Substantial Completion of the Work. The Owner and Contractor waive all Claims and causes of action not commenced in accordance with this Section 15.1.2.

§ 15.1.3 Notice of Claims

§ 15.1.3.1 Claims by either the Owner or Contractor, where the condition giving rise to the Claim is first discovered prior to expiration of the period for correction of the Work set forth in Section 12.2.2, shall be initiated by notice to the other party and to the Initial Decision Maker with a copy sent to the Architect, if the Architect is not serving as the Initial Decision Maker. Claims by either party under this Section 15.1.3.1 shall be initiated within 21 days after occurrence of the event giving rise to such Claim or within 21 days after the claimant first recognizes the condition giving rise to the Claim, whichever is later.

§ 15.1.3.2 Claims by either the Owner or Contractor, where the condition giving rise to the Claim is first discovered after expiration of the period for correction of the Work set forth in Section 12.2.2, shall be initiated by notice to the other party. In such event, no decision by the Initial Decision Maker is required.

§ 15.1.4 Continuing Contract Performance

§ 15.1.4.1 Pending final resolution of a Claim, except as otherwise agreed in writing or as provided in Section 9.7 and Article 14, the Contractor shall proceed diligently with performance of the Contract and the Owner shall continue to make payments in accordance with the Contract Documents.

§ 15.1.4.2 The Contract Sum and Contract Time shall be adjusted in accordance with the Initial Decision Maker's decision, subject to the right of either party to proceed in accordance with this Article 15. The Architect will issue Certificates for Payment in accordance with the decision of the Initial Decision Maker.

§ 15.1.5 Claims for Additional Cost

If the Contractor wishes to make a Claim for an increase in the Contract Sum, notice as provided in Section 15.1.3 shall be given before proceeding to execute the portion of the Work that is the subject of the Claim. Prior notice is not required for Claims relating to an emergency endangering life or property arising under Section 10.4.

§ 15.1.6 Claims for Additional Time

§ 15.1.6.1 If the Contractor wishes to make a Claim for an increase in the Contract Time, notice as provided in Section

15.1.3 shall be given. The Contractor's Claim shall include an estimate of cost and of probable effect of delay on progress of the Work. In the case of a continuing delay, only one Claim is necessary.

§ 15.1.6.2 If adverse weather conditions are the basis for a Claim for additional time, such Claim shall be documented by data substantiating that weather conditions were abnormal for the period of time, could not have been reasonably anticipated, and had an adverse effect on the scheduled construction.

§ 15.1.7 Waiver of Claims for Consequential Damages

The Contractor and Owner waive Claims against each other for consequential damages arising out of or relating to this Contract. This mutual waiver includes

- **.1** damages incurred by the Owner for rental expenses, for losses of use, income, profit, financing, business and reputation, and for loss of management or employee productivity or of the services of such persons; and
- **.2** damages incurred by the Contractor for principal office expenses including the compensation of personnel stationed there, for losses of financing, business and reputation, and for loss of profit, except anticipated profit arising directly from the Work.

This mutual waiver is applicable, without limitation, to all consequential damages due to either party's termination in accordance with Article 14. Nothing contained in this Section 15.1.7 shall be deemed to preclude assessment of liquidated damages, when applicable, in accordance with the requirements of the Contract Documents.

§ 15.2 Initial Decision

§ 15.2.1 Claims, excluding those where the condition giving rise to the Claim is first discovered after expiration of the period for correction of the Work set forth in Section 12.2.2 or arising under Sections 10.3, 10.4, and 11.5, shall be referred to the Initial Decision Maker for initial decision. The Architect will serve as the Initial Decision Maker, unless otherwise indicated in the Agreement. Except for those Claims excluded by this Section 15.2.1, an initial decision shall be required as a condition precedent to mediation of any Claim. If an initial decision has not been rendered within 30 days after the Claim has been referred to the Initial Decision Maker, the party asserting the Claim may demand mediation and binding dispute resolution without a decision having been rendered. Unless the Initial Decision Maker and all affected parties agree, the Initial Decision Maker will not decide disputes between the Contractor and persons or entities other than the Owner.

§ 15.2.2 The Initial Decision Maker will review Claims and within ten days of the receipt of a Claim take one or more of the following actions: (1) request additional supporting data from the claimant or a response with supporting data from the other party, (2) reject the Claim in whole or in part, (3) approve the Claim, (4) suggest a compromise, or (5) advise the parties that the Initial Decision Maker is unable to resolve the Claim if the Initial Decision Maker lacks sufficient information to evaluate the merits of the Claim or if the Initial Decision Maker concludes that, in the Initial Decision Maker's sole discretion, it would be inappropriate for the Initial Decision Maker to resolve the Claim.

§ 15.2.3 In evaluating Claims, the Initial Decision Maker may, but shall not be obligated to, consult with or seek information from either party or from persons with special knowledge or expertise who may assist the Initial Decision Maker in rendering a decision. The Initial Decision Maker may request the Owner to authorize retention of such persons at the Owner's expense.

§ 15.2.4 If the Initial Decision Maker requests a party to provide a response to a Claim or to furnish additional supporting data, such party shall respond, within ten days after receipt of the request, and shall either (1) provide a response on the requested supporting data, (2) advise the Initial Decision Maker when the response or supporting data will be furnished, or (3) advise the Initial Decision Maker that no supporting data will be furnished. Upon receipt of the response or supporting data, if any, the Initial Decision Maker will either reject or approve the Claim in whole or in part.

§ 15.2.5 The Initial Decision Maker will render an initial decision approving or rejecting the Claim, or indicating that the Initial Decision Maker is unable to resolve the Claim. This initial decision shall (1) be in writing; (2) state the reasons therefor; and (3) notify the parties and the Architect, if the Architect is not serving as the Initial Decision Maker, of any change in the Contract Sum or Contract Time or both. The initial decision shall be final and binding on the parties but subject to mediation and, if the parties fail to resolve their dispute through mediation, to binding dispute resolution.

§ 15.2.6 Either party may file for mediation of an initial decision at any time, subject to the terms of Section 15.2.6.1.

§ 15.2.6.1 Either party may, within 30 days from the date of receipt of an initial decision, demand in writing that the other party file for mediation. If such a demand is made and the party receiving the demand fails to file for mediation within 30 days after receipt thereof, then both parties waive their rights to mediate or pursue binding dispute resolution proceedings with respect to the initial decision.

§ 15.2.7 In the event of a Claim against the Contractor, the Owner may, but is not obligated to, notify the surety, if any, of the nature and amount of the Claim. If the Claim relates to a possibility of a Contractor's default, the Owner may, but is not obligated to, notify the surety and request the surety's assistance in resolving the controversy.

§ 15.2.8 If a Claim relates to or is the subject of a mechanic's lien, the party asserting such Claim may proceed in accordance with applicable law to comply with the lien notice or filing deadlines.

§ 15.3 Mediation

§ 15.3.1 Claims, disputes, or other matters in controversy arising out of or related to the Contract, except those waived as provided for in Sections 9.10.4, 9.10.5, and 15.1.7, shall be subject to mediation as a condition precedent to binding dispute resolution.

§ 15.3.2 The parties shall endeavor to resolve their Claims by mediation which, unless the parties mutually agree otherwise, shall be administered by the American Arbitration Association in accordance with its Construction Industry Mediation Procedures in effect on the date of the Agreement. A request for mediation shall be made in writing, delivered to the other party to the Contract, and filed with the person or entity administering the mediation. The request may be made concurrently with the filing of binding dispute resolution proceedings but, in such event, mediation shall proceed in advance of binding dispute resolution proceedings, which shall be stayed pending mediation for a period of 60 days from the date of filing, unless stayed for a longer period by agreement of the parties or court order. If an arbitration is stayed pursuant to this Section 15.3.2, the parties may nonetheless proceed to the selection of the arbitrator(s) and agree upon a schedule for later proceedings.

§ 15.3.3 Either party may, within 30 days from the date that mediation has been concluded without resolution of the dispute or 60 days after mediation has been demanded without resolution of the dispute, demand in writing that the other party file for binding dispute resolution. If such a demand is made and the party receiving the demand fails to file for binding dispute resolution within 60 days after receipt thereof, then both parties waive their rights to binding dispute resolution proceedings with respect to the initial decision.

§ 15.3.4 The parties shall share the mediator's fee and any filing fees equally. The mediation shall be held in the place where the Project is located, unless another location is mutually agreed upon. Agreements reached in mediation shall be enforceable as settlement agreements in any court having jurisdiction thereof.

§ 15.4 Arbitration

§ 15.4.1 If the parties have selected arbitration as the method for binding dispute resolution in the Agreement, any Claim subject to, but not resolved by, mediation shall be subject to arbitration which, unless the parties mutually agree otherwise, shall be administered by the American Arbitration Association in accordance with its Construction Industry Arbitration Rules in effect on the date of the Agreement. The Arbitration shall be conducted in the place where the Project is located, unless another location is mutually agreed upon. A demand for arbitration shall be made in writing, delivered to the other party to the Contract, and filed with the person or entity administering the arbitration. The party filing a notice of demand for arbitration must assert in the demand all Claims then known to that party on which arbitration is permitted to be demanded.

§ 15.4.1.1 A demand for arbitration shall be made no earlier than concurrently with the filing of a request for mediation, but in no event shall it be made after the date when the institution of legal or equitable proceedings based on the Claim would be barred by the applicable statute of limitations. For statute of limitations purposes, receipt of a written demand for arbitration by the person or entity administering the arbitration shall constitute the institution of legal or equitable proceedings based on the Claim.

§ 15.4.2 The award rendered by the arbitrator or arbitrators shall be final, and judgment may be entered upon it in accordance with applicable law in any court having jurisdiction thereof.

§ 15.4.3 The foregoing agreement to arbitrate and other agreements to arbitrate with an additional person or entity duly

consented to by parties to the Agreement, shall be specifically enforceable under applicable law in any court having jurisdiction thereof.

§ 15.4.4 Consolidation or Joinder

§ 15.4.4.1 Subject to the rules of the American Arbitration Association or other applicable arbitration rules, either party may consolidate an arbitration conducted under this Agreement with any other arbitration to which it is a party provided that (1) the arbitration agreement governing the other arbitration permits consolidation, (2) the arbitrations to be consolidated substantially involve common questions of law or fact, and (3) the arbitrations employ materially similar procedural rules and methods for selecting arbitrator(s).

§ 15.4.4.2 Subject to the rules of the American Arbitration Association or other applicable arbitration rules, either party may include by joinder persons or entities substantially involved in a common question of law or fact whose presence is required if complete relief is to be accorded in arbitration, provided that the party sought to be joined consents in writing to such joinder. Consent to arbitration involving an additional person or entity shall not constitute consent to arbitration of any claim, dispute or other matter in question not described in the written consent.

§ 15.4.4.3 The Owner and Contractor grant to any person or entity made a party to an arbitration conducted under this Section 15.4, whether by joinder or consolidation, the same rights of joinder and consolidation as those of the Owner and Contractor under this Agreement.

DOCUMENT 00 73 00 - SUPPLEMENTARY CONDITIONS

PART 1 - GENERAL

1.1 ARTICLE 1 GENERAL PROVISIONS

A. The following supplements modify AIA Document A201-2017, "General Conditions of the Contract for Construction." Where a portion of the General Conditions is modified or deleted by these Supplementary Conditions, the unaltered portions of the General Conditions remain in effect.

B. § 1.1 Basic Definitions

1. § 1.1.1 The Contract Documents

a. Add Section 1.1.1.1.

1) § 1.1.1.1 The Contract Documents executed or identified in accordance with the Agreement prevail in case of inconsistency with subsequent versions made through manipulatable electronic operations.

2. § 1.1.5 The Drawings

a. Add Section 1.1.5.1.

1) § 1.1.5.1 Where only part of the Work is indicated, similar parts are considered repetitive. Where any detail is shown and components thereof are fully described, similar details not fully described are deemed to incorporate similar material and construction.

C. § 1.2 Correlation and Intent of the Contract Documents

1. Add Section 1.2.1.3.

a. § 1.2.1.3 The Contractor acknowledges and agrees that the Contract Documents are sufficient to provide for the completion of the Work, including Work whether shown or described, which may reasonably be inferred to be required for the completion of the Work in accordance with information given in the Contract Documents.

1.2 ARTICLE 3 CONTRACTOR

A. § 3.3 Supervision and Construction Procedures

1. Add the following sentence to the end of Section 3.3.2:

a. The Contractor and subcontractors, consultants, sub-consultants, and

vendors shall comply with applicable statutes and the following requirements.

2. Add Sections .1, .2, .3, .4, and .5 to Section 3.3.2.

    a. .1 An employee of the Contractor, subcontractor, consultant, sub-consultant, or vendor found to be a registered sex offender shall not perform any work under this Contract and shall not be permitted to enter Owner's property. Failure to comply may result in legal action and termination of the Contract for default.
    b. .2 It is the Contractor's responsibility to ensure that subcontractors, sub-consultants and vendors involved with this Project are in compliance with applicable statutes.
    c. .3 Employees of the Contractor, subcontractor, consultant, sub-consultant, and their vendors when on the Owner's property shall dress appropriately for a work environment and perform their work in a professional manner. Determination of compliance with this requirement shall be solely at the discretion of the Owner. Contractor shall immediately have noncomplying personnel leave the Owner's property.
    d. .4 The Owner's facilities are tobacco-free facilities. Employees of the Contractor, subcontractor, consultant, sub-consultant, and their vendors shall refrain from use of tobacco products while on the Owner's property.
    e. .5 Employees of the Contractor, subcontractor, consultant, sub-consultant, and their vendors shall comply with the Contractor's safety program, and with state and federal safety regulations. The Contractor shall provide a copy of the Contractor's written safety program to the Owner within three business days of request.

B. § 3.4 Labor and Materials

1. Add Section 3.4.2.3.

    a. § 3.4.2.3 The Owner shall be entitled to reimbursement from the Contractor for amounts paid to the Architect for reviewing the Contractor's proposed substitutions and making agreed upon changes in the Drawings and Specifications resulting from such substitutions.

C. § 3.9 Superintendent

1. Add Sections .1 and .2 to Section 3.9.1.

    a. .1 The Superintendent shall be considered competent if it has successfully completed at least two other similar projects of similar scope and complexity to this Project while serving in the role of Project Superintendent.
    b. .2 The Superintendent shall be on-site while the Work is being performed.

2. Add Section 3.9.4.

    a. § 3.9.4 The Contractor shall maintain the same approved Project Manager and Field Superintendent from the time of issuance of the Notice to

Proceed until the Date of Substantial Completion, or shall submit proposed changes in personnel to the Architect in accordance with Section 3.9.2.

D. § 3.10 Contractor's Construction and Submittal Schedules

1. Add Section 3.10.4.

a. § 3.10.4 Based upon local weather data, the following 10-year average shall establish the number of rain days to be included in the Contractor's Construction Schedule as normal. Rain days are defined as periods of 24 hours within which precipitation is one-tenth (0.1) of an inch or greater. Rain days shall be understood to be workdays, exclusive of holidays, Sundays, and other nonworking days. Rain-related days will be considered based upon amounts of precipitation encountered during the construction process. The Contractor shall use these monthly averages when establishing the construction schedule for this project. Claims for delays due to abnormal rain delays will not be considered until the number of rain days during which critical path work is delayed exceeds the number allowed in the schedule as follows:

January:	7 Days	May:	11 Days	September:	12 Days
February:	6 Days	June:	5 Days	October:	6 Days
March:	6 Days	July:	7 Days	November:	9 Days
April:	7 Days	August:	7 Days	December:	7 Days

1) .1 Rain days, as identified above, are to aid contractors in their scheduling. These days are included in the total time allowed for construction as defined in Article 8 of these Supplementary Conditions. Used and unused days are not available for decreasing the Project Time nor may they be used to increase the Project Time unless the Contractor can prove its claim for weather-related delay based upon extreme conditions or Acts of God. Rain days shall cease upon the drying in/enclosure of the building.

1.3 ARTICLE 4 ARCHITECT

A. § 4.1 General

1. Add Section 4.1.1.1.

a. § 4.1.1.1 The term "Architect," "Architect/Engineer," or "Engineer" as used in the Contract Documents means the Architect or its authorized representative.

1.4 ARTICLE 5 SUBCONTRACTORS

A. § 5.2 Award of Subcontracts and Other Contracts for Portions of the Work

1. Add Section 5.2.1.1.

a. § 5.2.1.1 Included in the above notification shall be names of persons or entities proposed as manufacturers, fabricators, or material suppliers for the products, equipment and systems proposed for the Work.

1.5 ARTICLE 6 CONSTRUCTION BY OWNER OR BY SEPARATE CONTRACTORS

A. Owner will have an interiors contractor install, non-rated, gypsum systems, casework, plumbing fixtures will final connections, paint, flooring (except hanger/mechanical flooring systems), ceilings and lighting including final connections. This contract is responsible for coordinating with Owner's interior contractor..

1.6 ARTICLE 8 TIME

A. § 8.3 Delays and Extensions of Time

1. Add Section 8.3.4.

a. § 8.3.4 If the progress or completion of the Work is delayed by any fault, neglect, act or failure to act on the part of the Contractor or anyone acting for or on behalf of the Contractor, then the Contractor shall, in addition to all obligations imposed by this Contract and by law upon the Contractor, and at no cost or expense to the Owner, work such overtime or require the appropriate Subcontractor to work such overtime as may be necessary to make up for time lost and to avoid delay in the progress and completion of the Work. The Contractor shall pay the premium cost of such overtime work.

1) .1 For the purposes of this article, Subcontractors shall be deemed to be acting for and on behalf of the Contractor.

2. Add Sections 8.3.4.1 and 8.3.4.2.

a. § 8.3.4.1 Requests for extensions of time due to unusual adverse weather conditions occurring prior to completion of the roof and temporary or permanent building enclosure will be evaluated by the Owner when submitted by the Contractor in accordance with requirements of Section 012600 "Contract Modification Procedures."
b. § 8.3.4.2 Extensions of the Contract Time due to unusual adverse weather conditions do not entitle the Contractor to claims for cost due to extended project overhead.

3. Add Section 8.3.5.

a. § 8.3.5 Should the progress or completion of the Work be delayed by any fault, neglect, act or failure to act on the part of the Contractor or anyone acting for or on behalf of the Contractor so as to cause any additional cost, expense, liability or damage to the Owner or any damage or additional cost or expense for which the Owner may or shall become liable, the Contractor does hereby agree to compensate the Owner for, and to indemnify the

Owner against, all such costs, expenses, liabilities and damages.

1.7 ARTICLE 9 PAYMENTS AND COMPLETION

A. § 9.3 Applications for Payment

1. Add Sections 9.3.1.3 and 9.3.1.4.

a. § 9.3.1.4 The Owner may elect to reinstate the full Contract retainage if the manner of completion of the Work and its progress do not remain satisfactory to the Architect or if the Surety withholds or revokes its consent, or for other good and sufficient reasons.

2. Add Sections 9.3.2.1, 9.3.2.2 and 9.3.2.3.

a. § 9.3.2.1 In requesting payment for materials stored on- or off-site, the Contractor shall submit with its Application for Payment the following:

1) .1 an itemized list of the stored material prepared in sufficient detail to identify the materials and their value, and including adequate photographic evidence on the stored material in place. Include an accounting for new items stored, paid items that continue in storage, and items previously stored and since incorporated in the Work.
2) .2 evidence such as bills of sale or such other proof as may be requested by the Architect to substantiate that the materials listed have been paid for by the Contractor, or, for materials stored at the site only, a notarized statement from the materials supplier stating that the materials will become the property of the Owner upon payment by the Owner to the Contractor.

b. § 9.3.2.2 For material stored off-site, the Contractor shall additionally submit with its Application for Payment the following:

1) .1 evidence that the materials are stored at the location previously agreed to in writing as provided by Section 9.3.2 of the General Conditions. No payment will be made for material stored off the site until the storage location has been agreed upon in writing. No payment will be made for material stored more than 50 miles from the Project site.
2) .2 evidence that the storage location is bonded in a manner satisfactory to the Architect.
3) .3 evidence that the materials are insured while in storage and while in transit to the site.
4) .4 evidence that transportation to the site will be provided by the Contractor.

c. § 9.3.2.3 Stored materials may be reviewed in their storage location by the Architect.

B. § 9.8 Substantial Completion

1. Add Section 9.8.1.1.

    a. § 9.8.1.1 Substantial Completion shall also include final approval for occupancy and use by authorities having jurisdiction.

2. Add Sections 9.8.2.1 and 9.8.2.2.

    a. § 9.8.2.1 The Architect shall be entitled to rely upon the Contractor's comprehensive list of items to be completed or corrected in conjunction with the Architect's inspection to determine whether the Work or a designated portion thereof has attained Substantial Completion in accordance with the Contract Documents. The Owner shall be entitled to deduct from the Contract Sum amount paid to the Architect for preparation of such comprehensive list of items if such preparation is required to facilitate the Architect's determination of Substantial Completion.
    b. § 9.8.2.2 The Architect will review the general condition of the Work and the Contractor's comprehensive list prior to the Architect's inspection to determine whether the nature or scope of Work left to be completed or corrected will preclude immediate and full owner occupancy, and will not proceed with inspection for Substantial Completion, but will reschedule the inspection at such time that the Contractor has indicated that the Work remaining to be completed or corrected is consistent with the definition of Substantial Completion.

C. § 9.10 Final Completion and Final Payment

1. Add Section 9.10.2.1.

    a. § 9.10.2.1 The Contractor shall furnish such evidence as may be necessary to show that out-of-state subcontractors or suppliers have fully met the requirements of payment of taxes as established in the law of the State or local subdivision thereof, which may be in effect at the time of final payment. The Owner will require the submission of such proof or evidence before final payment is approved or made.

2. Add Section 9.10.3.1.

    a. § 9.10.3.1 Owner's Option Final Payment: If at the time Final Completion is scheduled there are remaining uncompleted items, the Contract may be closed and Contract closeout completed with an amount equal to 250 percent of the value of uncompleted items as determined by the Architect withheld as value to the Owner to provide for the Owner's completion of the Work and related costs for the Owner's and the Architect's additional services.

3. Add Sections .5, .6, and .7 to Section 9.10.4.

    a. .5 claims for Indemnification;
    b. .6 claims about which the Owner has given the Contractor written notice;
    c. .7 claims arising after final payment.

1.8 ARTICLE 10 PROTECTION OF PERSONS AND PROPERTY

A. § 10.2 Safety of Persons and Property

1. Add Section 10.2.2.1.

a. § 10.2.2.1 In the event that review, inspection, or other action by regulatory agencies or other parties results in the imposition of fines, fees, or other costs due to the failure of the Contractor to comply with said applicable laws, ordinances, rules, regulations and lawful orders, the Contractor shall hold harmless the Owner, the Architect, and the Owner's Separate Contractors, if any, from all consequences arising from the Contractor's noncompliance.

B. § 10.4 Emergencies

1. Add the following sentence to Section 10.4:

a. Nothing in this paragraph shall be construed as relieving the Contractor from the cost and responsibility for emergencies covered hereby, which with normal diligence, planning, and the close supervision of the Work as required under the Contract, could have been foreseen or prevented.

1.9 ARTICLE 12 UNCOVERING AND CORRECTION OF WORK

A. § 12.2 Correction of Work

1. Add Section 12.2.2.1.1.

a. § 12.2.2.1.1 Leakproof Envelope Provision: The one-year period for correction of Work shall be extended to a two-year period for all exterior envelope elements of the Work should one or more fail to serve as a leakproof water and/or air barrier. The Contractors responsibility under this Section shall extend to the repair of all damage to the building and building contents resulting from such failure.

2. Delete the words "one-year" from Subparagraphs 12.2.2.2 and 12.2.2.3.

B. § 12.3 Acceptance of Nonconforming Work

1. Add the following sentence to the end of Section 12.3:

a. The acceptance of nonconforming Work by the Owner shall be by written Change Order or Construction Change Directive, signed by the Owner's authorized representative. No person has authority to accept nonconforming Work except the Owner.

1.10 ARTICLE 13 MISCELLANEOUS PROVISIONS

A. Add Section 13.6.

1. § 13.6 Special Conditions

    a. See Owner's Special Conditions document(s) appended to and made a part of these Supplementary Conditions, which include the following:

        1) § 13.6.1 Provisions Required by law.
        2) § 13.6.2 Other Required Provisions.
        3) § 13.6.3 Student Privacy Provisions for Technology Agreement.
        4) § 13.6.4 Owner Direct Purchase Process.

1.11 ARTICLE 16 LIQUIDATED DAMAGES

A. Add Article 16.

B. § 16.1 The Owner and Contractor recognize that time is of the essence to this Contract and that a delay in achieving Substantial Completion or Final Completion is a breach and will cause damages to the Owner. Such damages include, but are not limited to, the following:

1. .1 delayed or diminished use of facility;
2. .2 inconvenience to facility users;
3. .3 increased inspection, oversight, and administrative costs to the Owner;
4. .4 diversion of the Owner's employees from other tasks and projects.;
5. .5 increased and extended project overhead;
6. .6 inefficiencies and loss of productivity;

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF DOCUMENT 00 73 00

SECTION 01 10 00 - SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Work performed by Owner.
4. Contractor's use of site and premises.
5. Coordination with occupants.
6. Work restrictions.
7. Specification and Drawing conventions.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.2 PROJECT INFORMATION

A. Project Identification: TM Aviation Hangar at LXT.

1. Project Location: Lee's Summit Airport, Lee's Summit, MO.

B. Owner: TMA Aviation, LLC.

1. Owner's Representative: .

C. Architect: Wellner Architects + Engineers.

1. Architect's Representative: .

D. Architect's Consultants: Architect has retained the following design professionals, who have prepared designated portions of the Contract Documents:

1. Structural Engineering: Professional Engineering Consultants.

a. Representative: .

2. Civil Engineering: CMT Engineering

1.3 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and includes, but is not

limited to, the following:

1. Project consists of new 90’ x 130’ aircraft hangar with office space. Adjacent parking lot with security fence. Aircraft apron and taxiway. Utilities from public right of way to the building. Modification of existing airport perimeter fence. and other Work indicated in the Contract Documents.

B. Type of Contract:

1. Project will be constructed under a single prime contract.

1.4 WORK PERFORMED BY OWNER

A. Cooperate fully with Owner, so work may be carried out smoothly, without interfering with or delaying Work under this Contract or work by Owner. Coordinate the Work of this Contract with work performed by Owner.

B. Concurrent Work: Owner will perform the following construction operations at Project site. Those operations will be conducted simultaneously with Work under this Contract.

1.5 OWNER-FURNISHED/CONTRACTOR-INSTALLED (OFCI) PRODUCTS

A. Owner's Responsibilities: Owner will furnish products indicated and perform the following, as applicable:

1. Provide to Contractor Owner-reviewed Product Data, Shop Drawings, and Samples.
2. Provide for delivery of Owner-furnished products to Project site.
3. Upon delivery, inspect, with Contractor present, delivered items.

    a. If Owner-furnished products are damaged, defective, or missing, arrange for replacement.

4. Obtain manufacturer's inspections, service, and warranties.
5. Inform Contractor of earliest available delivery date for Owner-furnished products.

B. Contractor's Responsibilities: The Work includes the following, as applicable:

1. Designate delivery dates of Owner-furnished products in Contractor's construction schedule, utilizing Owner-furnished earliest available delivery dates.
2. Review Owner-reviewed Product Data, Shop Drawings, and Samples, noting discrepancies and other issues in providing for Owner-furnished products in the Work.
3. Receive, unload, handle, store, protect, and install Owner-furnished products.
4. Make building services connections for Owner-furnished products.
5. Protect Owner-furnished products from damage during storage, handling, and installation and prior to Substantial Completion.
6. Repair or replace Owner-furnished products damaged following receipt.

C. Owner-Furnished/Contractor-Installed (OFCI) Products:

1. Equipment per drawings.

1.6 CONTRACTOR'S USE OF SITE AND PREMISES

A. Limits on Use of Site: Limit use of Project site to areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

1. Limits on Use of Site: Confine construction operations to limits of grading.
2. Driveways, Walkways and Entrances: Keep driveways loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or for storage of materials.

a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

1.7 WORK RESTRICTIONS

A. Comply with restrictions on construction operations.

1. Comply with limitations on use of public streets, work on public streets, rights of way, and other requirements of authorities having jurisdiction.

B. On-Site Work Hours: Limit work to between 5 a.m. to 10 p.m., Monday through Friday, unless otherwise indicated. Work hours may be modified to meet Project requirements if approved by Owner and authorities having jurisdiction.

1. Weekend Hours: Limit work to between 8 a.m. to 5 p.m..

C. Smoking and Controlled Substance Restrictions: Use of tobacco products , alcoholic beverages, and other controlled substances on Project site is not permitted.

1.8 SPECIFICATION AND DRAWING CONVENTIONS

A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.

B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:

1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
2. Abbreviations: Materials and products are identified by abbreviations scheduled on Drawings.
3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF SECTION 01 10 00

SECTION 01 22 00 - UNIT PRICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for unit prices.

B. Related Requirements:

1. Section 012100 "Allowances" for procedures for using unit prices to adjust quantity allowances.
2. Section 012600 "Contract Modification Procedures" for procedures for submitting and handling Change Orders.
3. Section 014000 "Quality Requirements" for field testing by an independent testing agency.

1.2 DEFINITIONS

A. Unit price is an amount incorporated into the Agreement, applicable during the duration of the Work as a price per unit of measurement for materials, equipment, or services, or a portion of the Work, added to or deducted from the Contract Sum by appropriate modification, if the scope of Work or estimated quantities of Work required by the Contract Documents are increased or decreased.

1.3 PROCEDURES

A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, applicable taxes,overhead, and profit.

B. Measurement and Payment: See individual Specification Sections for work that requires establishment of unit prices. Methods of measurement and payment for unit prices are specified in those Sections.

C. Owner reserves the right to reject Contractor's measurement of work-in-place that involves use of established unit prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.

D. List of Unit Prices: A schedule of unit prices is included in Part 3. Specification Sections referenced in the Part 3 "Schedule of Unit Prices" Article contain requirements for materials described under each unit price.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION

3.1 SCHEDULE OF UNIT PRICES

~~A. Unit Price No. 1: Removal of unsatisfactory soil and replacement with satisfactory soil material.~~

~~1. Description: Unsatisfactory soil excavation and disposal off-site and replacement with satisfactory fill material or engineered fill from off-site, as required, in accordance with Section 312000 "Earth Moving."~~
~~2. Unit of Measurement: <**Insert cubic yard**> of soil excavated, based on in-place surveys of volume before and after removal.~~
~~3. Quantity Allowance: Coordinate unit price with allowance adjustment requirements in Section 012100 "Allowances."~~

~~B. Unit Price No. 2: Mass rock excavation and replacement with satisfactory soil material.~~

~~1. Description: Classified mass rock excavation and disposal off-site and replacement with satisfactory fill material or engineered fill from off-site, as required, in accordance with Section 312000 "Earth Moving."~~
~~2. Unit of Measurement: <**Insert cubic yard**> of rock excavated, based on in-place surveys of volume before and after removal.~~
~~3. Quantity Allowance: Coordinate unit price with allowance adjustment requirements in Section 012100 "Allowances."~~

C. Unit Price No. 3: Miscellaneous steel rebar.

1. Description: Miscellaneous lintels and other supports not otherwise indicated in the Contract Documents, in accordance with Section 03 20 00 "Concrete Reinforcing".
2. Unit of Measurement: Cost in place of ½ ton of fabricated steel, as indicated on itemized invoice of steel supplier.

D. Unit Price No. 4: Miscellaneous and structural steel.

1. Description: Miscellaneous lintels and other supports not otherwise indicated in the Contract Documents, in accordance with Section 051200 "Structural Steel Framing" and Section 055000 "Metal Fabrications."
2. Unit of Measurement: Cost in place of 2,000lbs of fabricated steel, as indicated on itemized invoice of steel supplier.

E. Unit Price No. 5: Miscellaneous concrete foundations.

1. Description: Miscellaneous concrete foundations in accordance with Section 03 30 00 "Cast In Place Concrete>."
2. Unit of Measurement: 4 cubic yards
3. Quantity Allowance: Coordinate unit price with allowance adjustment requirements in Section 012100 "Allowances."

END OF SECTION 01 22 00

~~SECTION 012200 - UNIT PRICES~~ SECTION 012200.13 - UNIT COST

PART 1 - GENERAL

1-1 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1-2 SUMMARY

A. This Section includes administrative and procedural requirements for unit prices.

B. Related Sections include the following:

Division 01 Section "Contract Modification Procedures" for procedures for submitting and handling Change Orders.

Form 00412 Unit Price – Listing of Unit Prices

1-3 DEFINITIONS

Unit price is **an amount proposed by bidders, stated on the Bid Form, as** a price per unit of measurement for materials or services rendered by the bidder, added to or deducted from the Contract Sum by appropriate modification, if estimated quantities of work required by the Contract Documents are increased or decreased, as payment for work completed by the bidder and accepted by the owner.

1-4 PROCEDURES

Unit prices include full compensation for all necessary material, equipment, tools; and labor & installation, plus cost for delivery, disposal, testing, insurance, maintaining work, **applicable taxes,** incidentals; and all indirect costs such as overhead, and profit.

Measurement and Payment: Methods of measurement and payment for unit prices are specified in this Section. The unit prices are defined in the bid schedule by item number, item description, and unit.

A. The CITY reserves the right to reject Contractor's measurement of work-in-place that involves use of established unit prices and to have this work measured, at CITY's expense, by an independent surveyor acceptable to Contractor.

B. List of Unit Prices: A list of unit prices is included in Form 00412 Unit Prices. Specification Sections referenced in the list contain requirements for materials described under each unit price.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

PART 4 PAY ITEMS – **BASE BID**

4-1 EXISTING ROAD REMOVAL – PER LUMP SUM

A. Description

This item will include demolition, removal and disposal of the existing roadway full depth according to the limits identified on the plans. No distinction will be made for the type, thickness or condition of pavement removed. The limits of removal will be first marked out and reviewed before the demolition and removal operations begin. This item will include roadway demolition, removal, and disposal by the Contractor and hauled offsite.

B. Method of Measurement

There will be no measurement for roadway removal. Road removal is a lump sum unit for item of work completed and accepted. The quantity of road removal by area on a horizontal plane is as shown on the plan drawings.

1 Sawcutting around the periphery of the removal limits will be considered a subsidiary obligation of the contractor and no direct measurement will be made.

C. Basis of Payment:

Payment will be made at contract unit price for the unit of measurement as specified above. This price will be full compensation for all preparation, sawcutting, loading, dust control, hauling, disposal, ground restoration, and for all labor, equipment, tools, and incidentals necessary to complete this item.

D. Payment will be made under:

Existing Road Removal – per lump sum.

4-2 EROSION CONTROL – PER LUMP SUM

A. Method Measurement.

There will be no measurement for erosion control. Erosion Control is a lump sum unit for all the erosion control work completed and accepted.

B. Basis of Payment.

Based upon the contract lump sum price for erosion control, partial payments will be allowed as follows:

1 When 50% or more of the contract is earned, 50%

2 After the work is substantially completed and all areas of the site have a stand of grass established in compliance with the seed and mulching specification and all erosion and sediment is removed, the final 50%

C. Payment will be made under:

Erosion Control – per lump sum

4-3 FENCE REMOVAL – PER LINEAR FOOT

A. Method of Measurement.

The unit of measurement for fence removal will be the length in linear feet of existing fence including reinforced concrete post foundations removed by the Contractor, regardless of type, fence height, barbed wire or actual size & weight of fabric encountered in the field. This item will include removal of existing posts, concrete post foundations, ground rods, ground wire; and backfilling of holes in voids in the subgrade; and grading resulting in a smooth finished grade; and ground restoration including seeding and mulching to establish a stand of grass as defined in the specifications.

The length will be measured in a straight line from corner post to corner post and to gate posts. Gate removal will be counted as fence removal per linear foot.

B. Basis of Payment.

Payment will be made at the contract unit price for the unit of measurement as specified above. This price will be full compensation for all preparation, demolition, sawcutting, hauling, disposal, ground restoration; and for all labor, equipment, tools, and incidentals necessary to complete this item.

C. Payment will be made under:

Fence Removal – per linear foot

4-4 MAINTENANCE OF TRAFFIC – PER LUMP SUM

A. Description

The work will consist of providing, installing, maintaining and removal of traffic control devices. This work includes, but is not limited to installing, maintaining, realignment, relocation and removal of temporary traffic control devices, signage, fencing; and the scheduling and sequencing of construction operations and coordination of such; and the scheduling necessary to maintain aircraft, vehicular and pedestrian traffic. This item includes 24-hour maintenance of the said traffic control measures over the duration of the contract until final acceptance of the project by the owner.

B. Method of Measurement

There will be no direct measure of maintenance of traffic. It is a lump sum unit - paid out incrementally as defined below:

C. Basis of Payment:

Based upon the contract lump sum price for maintenance of traffic, partial payments will be allowed as follows:

3 With first pay request, 25%

4 When 25% or more of the base bid contract is earned, an additional 25%

5 When 50% or more of the base bid contract is earned, an additional 25%

6 After the work is substantially completed, all areas of the site are safely re-opened to vehicle or pedestrian traffic, the final 25%

D. Payment will be made under:

Maintenance of Traffic – per lump sum

4-5 ELECTRIC BLACK VINYL BI-DIRECTIONAL ROLLING GATE SYSTEM – PER EACH

A. The unit of measurement for the rolling gate system will be per each installed item as shown according to the plan details and accepted.

B. Payment will be made at the contract unit price for the unit of measurement as specified above. This price will be full compensation for furnishing all materials and for all preparation, and for all labor, equipment, tools, and incidentals necessary to complete this item.

C. Payment will be made under:

Electric Black Vinyl Bi-Directional Rolling Gate System – per each

4-6 12" CEMENT-TREATED SUBGRADE – PER SQUARE YARD

A. The amount of cement-treated subgrade constructed per Section 2202 Subgrade Stabilization at the specified thickness will be measured by the square yard, completed, accepted in place as compliant with the specification.

B. This item will include but not be limited to all preparation, loading, placing, mixing, watering, compacting, roll testing; and trimming; and all required testing and documentation as required for this item.

C. This item will also include providing dust control & maintaining the subgrade in good condition from the start of work until all the work has been completed, cured and the pavement placed.

D. Payment will be made at the contract unit price per square yard for the cement-treated subgrade at the thickness specified. The price will be full compensation for furnishing all materials, except for cement and for all preparation, delivering, mixing, compacting, watering, and all labor, equipment, tools and incidentals necessary to complete this item.

E. Payment will be made under:

Cement-Treated Subgrade – per square yard

4-7 CEMENT (SOIL STABILIZATION) – PER TON

A. Cement will be measured by the number of tons or tenth part thereof delivered to the project, spread and accepted. Certified scale readings is the only basis for measurement and payment per ton.

B. Payment will be made at the contract unit price per ton for cement delivered to the project as compliant with the specification. The price will be full compensation for furnishing all materials, and for all preparation, and all labor, equipment, tools and incidentals necessary to complete this item.

C. Payment will be made under:

Cement (Soil Stabilization) – per ton

4-8 4" COMPACTED AGGREGATE BASE COURSE – PER SQUARE YARD

A. Final measurement will be based on the square yard of the completed and installed item.

B. Payment for 4" compacted aggregate base will be based on the unit price per square yard as set forth in the Agreement, per thickness of the installed item. Said price will include all costs necessary to complete the work including subgrade preparation, placing, compacting, moisture content, testing, reporting, curing and maintaining, as required by drawings and specifications. The price will be full compensation for furnishing all materials, and for all preparation, delivering, mixing, compacting, and all labor, equipment, tools and incidentals necessary to complete this item.

C. Payment will be made under:

4" Compacted Aggregate Base Course – per square yard

4-9 9" PORTLAND CEMENT CONCRETE PAVEMENT – PER SQUARE YARD

A. Measurement of concrete pavement of the type and thickness specified will be based on the square yard of the material, completed and accepted in place.

B. Payment for 9" Portland cement concrete pavement will be based on the unit price per square yard as set forth in the Agreement, per thickness of the installed item. The price will be full compensation for furnishing all materials, and for all preparation, delivering, mixing, compacting, and all labor, equipment, tools and incidentals necessary to complete this item.

C. Payment will be made under:

9" Portland Cement Concrete Pavement – per square yard

4-10 8" PORTLAND CEMENT CONCRETE PAVEMENT – PER SQUARE YARD

A. Measurement of PCC pavement of the type and thickness specified will be based on the square yard of the material, completed and accepted in place.

B. Payment for PCC concrete of the thickness specified will be based on the unit price per square yard as set forth in the Agreement of the installed item. The price will be full compensation for furnishing all materials, and for all preparation, delivering, mixing, compacting, and all labor, equipment, tools and incidentals necessary to complete this item.

C. Payment will be made under:

8" Portland Cement Concrete pavement – per square yard

4-11 4" PORTLAND CEMENT CONCRETE SIDEWALK – PER SQUARE YARD

A. Measurement of sidewalk of the type and thickness specified will be based on the square yard of the material, completed and accepted in place.

B. Payment for concrete sidewalk of the thickness specified will be based on the unit price per square yard as set forth in the Agreement of the installed item. The price will be full compensation for furnishing all materials, and for all preparation, delivering, mixing, compacting, and all labor, equipment, tools and incidentals necessary to complete this item.

C. Payment will be made under:

4" Portland Cement Concrete Sidewalk – per square yard

4-12 TYPE CG-1 CONCRETE CURB AND GUTTER – PER LINEAR FOOT

A. Measurement for concrete curb and gutter of the type and dimensions specified will be by the linear foot.

B. Payment for concrete curb and gutter will be at the contract unit price per linear foot as set forth in the agreement of the type and dimensions specified. The price will be full compensation for furnishing all materials, and for all preparation, delivering, mixing, compacting, and all labor, equipment, tools and incidentals necessary to complete this item.

C. Payment will be made under:

Type CG-1 Concrete curb and gutter – per linear foot

4-13 4" YELLOW PARKING STALL WATERBORNE MARKINGS – PER LINEAR FOOT

A. Measurement for pavement stall waterborne marking of the type and width specified will be by the linear foot.

B. Payment for pavement marking will be at the contract unit price per linear foot as set forth in the agreement of the type and at the rate specified. The price will be full compensation for furnishing all materials, and for all preparation, delivering, mixing, compacting, and all labor, equipment, tools and incidentals necessary to complete this item. The price will be full compensation for furnishing all materials, and for all preparation, delivering, mixing, compacting, and all labor, equipment, tools and incidentals necessary to complete this item.

C. Payment will be made under:

4" Yellow Parking stall waterborne pavement marking – per linear foot

4-14 THERMOPLASTIC ADA ACCESSIBLE PARKING SYMBOL MARKINGS – PER EACH

A. Measurement for accessible pavement stall symbol of the dimensions and materials specified will be per each.

B. Payment for accessible pavement stall symbol marking will be at the contract unit price per each as set forth in the agreement of the type, dimension and material specified. The price will be full

compensation for furnishing all materials, and for all preparation, delivering, application, and all labor, equipment, tools and incidentals necessary to complete this item.

C. Payment will be made under:

Thermoplastic ADA accessible pavement symbol marking– per each

4-15 AGGREGATE OR SOIL MATERIAL FROM OFF-SITE – PER CUBIC YARD

A. The unit of measurement for materials from off-site will be made at the contract unit price per cubic yard of furnished material from off-site.

B. Furnishing material exceeding plan quantity awarded for this project will not be measured for payment without advance written approval of the Owner.

C. Payment will be made at the contract unit price for the unit of measurement as specified above. This price will be full compensation for furnishing all materials and for all preparation, hauling, disposal and placing of the material and for all labor, equipment, tools, and incidentals necessary to complete this item.

D. Payment will be made under:

Aggregate or Soil Material from Off-Site – per cubic yard

4-16 UNCLASSIFIED EXCAVATION – PER CUBIC YARD

A. The unit of measurement for Unclassified Excavation will be made at the contract unit price per cubic yard of excavated material from the existing site.

B. The Contractor is responsible to maintain the excavated areas until placement of the overlying layer as specified in the documents. No separate measurement will be made for temporary stockpiling or withdrawal from the stockpile but will be considered incidental to the unclassified excavation pay item per cubic yard.

C. The excavation of topsoil stripped from the project surface and stockpiled for later reuse is included in the measurement and payment of unclassified excavation per cubic yard. Stripped topsoil will remain on the project site for later distribution.

D. Excavation exceeding plan quantity awarded for this project will not be measured for payment without advance written approval of the Owner. The Contractor will agree to plan quantity before the Notice to Proceed is issued to start work.

E. Payment will be made at the contract unit price for the unit of measurement as specified above. This price will be full compensation for furnishing all materials and for all preparation, hauling, disposal and placing of the material and for all labor, equipment, tools, and incidentals necessary to complete this item.

F. Payment will be made under:

Unclassified Excavation – per cubic yard

4-17 SEEDING – PER ACRE

A. Measurement for seeding of the type and application rate specified will be by the acre or hundredth thereof as installed per the specification.

B. Payment for seeding will be at the contract unit price per acre or hundredth thereof as set forth in the agreement of the type and at the application rate of seed, lime and fertilizer specified. The price will be full compensation for furnishing all materials, and for all preparation, delivering, mixing, application, and all labor, equipment, tools and incidentals necessary to complete this item.

C. Payment will be made under:

Seeding – per acre

4-18 MULCHING – PER ACRE

A. Measurement for mulching of the type and application rate specified will be by the acre or hundredth thereof.

B. Payment for mulching will be at the contract unit price per acro or hundredth thereof as set forth in the agreement of the type and at the rate specified. The price will be full compensation for furnishing all materials, and for all preparation, delivering, mixing, application, and all labor, equipment, tools and incidentals necessary to complete this item.

C. Payment will be made under:

Mulching – per acre

4-19 FIRE HYDRANT ASSEMBLY (WITH NEW HYDRANT) – PER EACH

A. Measurement for fire hydrant assembly and installation of the type, dimensions and materials specified will be per each.

B. Payment for fire hydrant assembly will be at the contract unit price per each as set forth in the agreement of the type of material specified. The price will be full compensation for furnishing all materials, and for all preparation, delivering, installing, and all labor, equipment, tools and incidentals necessary to complete this item.

C. Payment will be made under:

Fire hydrant assembly (with New Hydrant) – per each

4-20 DRAINAGE – PER LUMP SUM

A. The measurement for drainage will be per lump sum installed per the plans and specification.

B. Payment for drainage will be at the contract unit price per each as set forth in the agreement for the type, materials, dimensions of items specified and installed. The price will be full

compensation for furnishing all materials, and for all preparation, delivering, installing, excavation & backfilling, and all labor, equipment, tools and incidentals necessary to complete this item.

C. Payment will be made under:

Drainage – per lump sum

4-21 8' BLACK VINYL CHAIN LINK FENCE WITH BARBED WIRE– PER LINEAR FOOT.

A. Measurement for new 8' black vinyl chain link fence with barbed wire of the type and dimensions specified will be by linear foot.

B. Payment for 8' black vinyl chain link fence with barbed wire will be at the contract unit price per linear foot as set forth in the agreement of the type and dimensions specified. The price will be full compensation for furnishing all materials, and for all preparation, delivery, installation, grounding, and all labor, equipment, tools and incidentals necessary to complete this item.

C. Payment will be made under:

8' Black vinyl chain link fence with barbed wire – per linear foot

4-22 NEW 4'X4'X4' HANDHOLE - PER EACH

A. Measurement for a new reinforced concrete handhold structure of the dimensions and materials specified, including metal casting will be per each. Excavation, backfilling and restoration will be included in this item and no separate measurement will be made. Measurement will be for the complete unit, in-place and accepted.

No distinction will be made between electric service and communication service hand holes for measurement and payment purposes.

B. Payment for new handhole structures will be at the contract unit price per each as set forth in the agreement of the size, type and material specified. The price will be full compensation for furnishing all materials, and for all preparation, delivering, installing, and all labor, equipment, tools and incidentals necessary to complete this item.

C. Payment will be made under:

New 4'x4'x4' handhole – per each

4-23 UTILITIES - ELECTRIC – PER LUMP SUM

A. Measurement for installing the underground electric service between the connection at the utility pole drop down or pedestal up to and into the exterior building wall, including a new transformer installed per Evergy standards and payment to Evergy for installation cost of their services will be

per lump sum. Measurement will be for the complete system, in-place, fully operational and accepted.

B. No separate measurement will be made for any component of the complete installation but will be included in the cost of the Utilities – Electric pay item per lump sum and no direct payment will be made.

C. Payment for the utilities – electric will be at the contract unit price per lump sum as set forth in the agreement and as specified and detailed on the drawings. Payment will include coordination with the utility, coordination with the building MEP, permitting, and payment to the utility for the installation and hook-up of their service complete. The price will be full compensation for furnishing all materials, and for all preparation, delivery, installation, and all labor, equipment, tools and incidentals necessary to complete this item.

D. Payment will be made under:

Utilities - Electric – per lump sum

4-24 UTILITIES - GAS – PER LUMP SUM

A. Measurement for installing the underground natural gas service between the connection point into the exterior building wall, including compliance with all the utility standards and payment to Spire for installation of their service will be per lump sum. Measurement for the natural gas utility will be for the complete system, in-place, fully operational and accepted.

B. No separate measurement will be made for any component of the complete installation but will be included in the cost of the Utilities – Gas pay item per lump sum and no direct payment will be made.

C. Payment for the utilities – gas will be at the contract unit price per lump sum as set forth in the agreement and as specified and detailed on the drawings. Payment will include coordination with the utility, coordination with the building MEP, permitting, and payment to the utility for the installation and hook-up of their service. The price will be full compensation for furnishing all materials, and for all preparation, delivery, installation, and all labor, equipment, tools and incidentals necessary to complete this item.

D. Payment will be made under:

Utilities – Gas – per lump sum

4-25 UTILITIES – WATER – PER LUMP SUM

A. Measurement for installing the underground water service between the connection tap into the exterior building wall, including meeting all utility standards and payment to Lee's Summit Water for installation of their service will be per lump sum. Measurement will be made for the complete system, in-place, fully operational and accepted.

B. No separate measurement will be made for any component of the complete installation including taps service connections, water service meter & reinforced concrete vault of correct size for water

meters but will be included in the cost of the Utilities – Water pay item per lump sum and no direct payment will be made.

C. Payment for the utilities – water will be at the contract unit price per lump sum as set forth in the agreement and as specified and detailed on the drawings. Payment will include coordination with the utility, coordination with the building MEP, permitting, and payment to the utility for the installation and hook-up of their service. The price will be full compensation for furnishing all materials, and for all preparation, delivery, installation, and all labor, equipment, tools and incidentals necessary to complete this item.

D. Payment will be made under:

Utilities – Water – per lump sum

4-26 UTILITIES - SANITARY SEWER – PER LUMP SUM

A. Measurement for installing the underground sanitary sewer service between the connection tap into the service main and into the exterior building wall, including compliance to all utility standards and payment to Lee's Summit Water for installation of their service will be per lump sum. Measurement will be made to make the installation of a complete system, in-place, fully operational and accepted.

B. No separate measurement will be made for any component of the complete installation including taps & connections but will be included in the cost of the Utilities – Sanitary Sewer pay item per lump sum and no direct payment will be made.

C. Payment for the utilities – sanitary sewer will be at the contract unit price per lump sum as set forth in the agreement and as specified and detailed on the drawings. Payment will include coordination with the utility, coordination with the building MEP, permitting, and payment to the utility for the installation and hook-up of their service as applicable. The price will be full compensation for furnishing all materials, and for all preparation, delivery, installation, and all labor, equipment, tools and incidentals necessary to complete this item.

D. Payment will be made under:

Utilities – Sanitary Sewer – per lump sum

PART 4 PAY ITEMS – **REIMBURSIBLE**

4-27 REMOVAL OF CONCRETE CURB AND GUTTER – PER LINEAR FOOT

A. Measurement for removal of concrete curb and gutter of the type and dimensions specified will be by the linear foot.

B. Payment for concrete curb and gutter will be at the contract unit price per linear foot as set forth in the agreement of the type and dimensions specified. The price will be full compensation for furnishing all materials, and for all preparation, delivering, mixing, compacting, and all labor, equipment, tools and incidentals necessary to complete this item.

C. Payment will be made under:

Removal of concrete curb and gutter – per linear foot

4-28 9" PORTLAND CEMENT CONCRETE PAVEMENT – PER SQUARE YARD

A. Measurement of concrete pavement of the type and thickness specified will be based on the square yard of the material, completed and accepted in place.

B. Payment for 9" Portland cement concrete pavement will be based on the unit price per square yard as set forth in the Agreement, per thickness of the installed item. The price will be full compensation for furnishing all materials, and for all preparation, delivering, mixing, compacting, and all labor, equipment, tools and incidentals necessary to complete this item.

C. Payment will be made under:

9" Portland Cement Concrete Pavement – per square yard

4-29 8" PORTLAND CEMENT CONCRETE PAVEMENT – PER SQUARE YARD

A. Measurement of PCC pavement of the type and thickness specified will be based on the square yard of the material, completed and accepted in place.

B. Payment for PCC concrete of the thickness specified will be based on the unit price per square yard as set forth in the Agreement of the installed item. The price will be full compensation for furnishing all materials, and for all preparation, delivering, mixing, compacting, and all labor, equipment, tools and incidentals necessary to complete this item.

C. Payment will be made under:

8" Portland Cement Concrete pavement – per square yard

4-30 4" COMPACTED AGGREGATE BASE COURSE – PER SQUARE YARD

A. Final measurement will be based on the square yard of the completed and installed item.

B. Payment for 4" compacted aggregate base will be based on the unit price per square yard as set forth in the Agreement, per thickness of the installed item. Said price will include all costs necessary to complete the work including subgrade preparation, placing, compacting, moisture content,

testing, reporting, curing and maintaining, as required by drawings and specifications. The price will be full compensation for furnishing all materials, and for all preparation, delivering, mixing, compacting, and all labor, equipment, tools and incidentals necessary to complete this item.

C. Payment will be made under:

4" Compacted Aggregate Base Course – per square yard

4-31 12" 6% CEMENT-TREATED SUBGRADE – PER SQUARE YARD

A. The amount of cement-treated subgrade constructed per Section 2202 Subgrade Stabilization at the specified thickness will be measured by the square yard, completed, accepted in place as compliant with the specification.

B. This item will include but not be limited to all preparation, loading, placing, mixing, watering, compacting, roll testing; and trimming; and all required testing and documentation as required for this item.

C. This item will also include providing dust control & maintaining the subgrade in good condition from the start of work until all the work has been completed, cured and the pavement placed.

D. Payment will be made at the contract unit price per square yard for the cement-treated subgrade at the thickness specified. The price will be full compensation for furnishing all materials, except for cement and for all preparation, delivering, mixing, compacting, watering, and all labor, equipment, tools and incidentals necessary to complete this item.

E. Payment will be made under:

Cement-Treated Subgrade – per square yard

4-32 CEMENT (SOIL STABILIZATION) – PER TON

A. Cement will be measured by the number of tons or tenth part thereof delivered to the project, spread and accepted. Certified scale readings is the only basis for measurement and payment per ton.

B. Payment will be made at the contract unit price per ton for cement delivered to the project as compliant with the specification. The price will be full compensation for furnishing all materials, and for all preparation, and all labor, equipment, tools and incidentals necessary to complete this item.

C. Payment will be made under:

Cement (Soil Stabilization) – per ton

4-33 TYPE CG-1 CONCRETE CURB AND GUTTER – PER LINEAR FOOT

A. Measurement for concrete curb and gutter of the type and dimensions specified will be by the linear foot.

B. Payment for concrete curb and gutter will be at the contract unit price per linear foot as set forth in the agreement of the type and dimensions specified. The price will be full compensation for furnishing all materials, and for all preparation, delivering, mixing, compacting, and all labor, equipment, tools and incidentals necessary to complete this item.

C. Payment will be made under:

Type CG-1 Concrete curb and gutter – per linear foot

4-34 EXCAVATION - AGGREGATE OR SOIL MATERIAL RECYCLED ON-SITE – PER CUBIC YARD

A. The unit of measurement for materials from off-site will be made at the contract unit price per cubic yard of furnished material from off-site.

B. Furnishing material exceeding plan quantity awarded for this project will not be measured for payment without advance written approval of the Owner.

C. Payment will be made at the contract unit price for the unit of measurement as specified above. This price will be full compensation for furnishing all materials and for all preparation, hauling, disposal and placing of the material and for all labor, equipment, tools, and incidentals necessary to complete this item.

D. Payment will be made under:

Aggregate or Soil Material from Off-Site – per cubic yard

4-35 UNCLASSIFIED EXCAVATION – PER CUBIC YARD

A. The unit of measurement for Unclassified Excavation will be made at the contract unit price per cubic yard of excavated material from the existing site.

B. The Contractor is responsible to maintain the excavated areas until placement of the overlying layer as specified in the documents. No separate measurement will be made for temporary stockpiling or withdrawal from the stockpile but will be considered incidental to the unclassified excavation pay item per cubic yard.

C. The excavation of topsoil stripped from the project surface and stockpiled for later reuse is included in the measurement and payment of unclassified excavation per cubic yard. Stripped topsoil will remain on the project site for later distribution.

D. Excavation exceeding plan quantity awarded for this project will not be measured for payment without advance written approval of the Owner. The Contractor will agree to plan quantity before the Notice to Proceed is issued to start work.

E. Payment will be made at the contract unit price for the unit of measurement as specified above. This price will be full compensation for furnishing all materials and for all preparation, hauling,

disposal and placing of the material and for all labor, equipment, tools, and incidentals necessary to complete this item.

F. Payment will be made under:

Unclassified Excavation – per cubic yard

4-36 4-WAY – 4" PVC CONCRETE ENCASED DUCT BANK – PER LINEAR FOOT

A. Measurement for the concrete encased duct bank of the type and materials specified will be per linear foot.

B. Payment for new concrete encased duct bank will be at the contract unit price per linear foot as set forth in the agreement of the type and material specified. The price will be full compensation for conduit, cable, trenching, backfill, and restoration.

C. Payment will be made under:

4-Way – 4" PVC Concrete encased duct bank – per linear foot

4-37 PAVEMENT MARKING REMOVAL – PER SQUARE FOOT

A. Measurement for marking removal of the material, color, type and width specified will be by the square foot.

B. Payment for marking removal will be at the contract unit price per square foot as set forth in the agreement of the type and at the rate specified. The price will be full compensation for furnishing all materials, and for all preparation, delivering, mixing, compacting, and all labor, equipment, tools and incidentals necessary to complete this item. The price will be full compensation for furnishing all materials, and for all preparation, delivering, mixing, compacting, and all labor, equipment, tools and incidentals necessary to complete this item.

C. Payment will be made under:

Waterborne paint, yellow with reflective media – per square foot

4-38 WATERBORNE PAINT, YELLOW WITH REFLECTIVE MEDIA – PER SQUARE FOOT

A. Measurement for waterborne paint marking of the color, type and width specified will be by the square foot.

B. Payment for waterborne paint marking will be at the contract unit price per square foot as set forth in the agreement of the type and at the rate specified. The price will be full compensation for furnishing all materials, and for all preparation, delivering, mixing, compacting, and all labor, equipment, tools and incidentals necessary to complete this item. The price will be full compensation for furnishing all materials, and for all preparation, delivering, mixing, compacting, and all labor, equipment, tools and incidentals necessary to complete this item.

C. Payment will be made under:

Waterborne paint, yellow with reflective media – per square foot

4-39 WATERBORNE PAINT, BLACK WITHOUT REFLECTIVE MEDIA – PER SQUARE FOOT

A. Measurement for waterborne paint marking of the color, type and width specified will be by the square foot.

B. Payment for waterborne paint marking will be at the contract unit price per square foot as set forth in the agreement of the type and at the rate specified. The price will be full compensation for furnishing all materials, and for all preparation, delivering, mixing, compacting, and all labor, equipment, tools and incidentals necessary to complete this item. The price will be full compensation for furnishing all materials, and for all preparation, delivering, mixing, compacting, and all labor, equipment, tools and incidentals necessary to complete this item.

C. Payment will be made under:

Waterborne paint, black without reflective media – per square foot

END OF SECTION 012200

SECTION 01 25 00 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for substitutions.

B. Related Requirements:

1. Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.2 DEFINITIONS

A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents.

1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required to meet other Project requirements but may offer advantage to Contractor or Owner.

1.3 ACTION SUBMITTALS

A. Substitution Requests: Submit documentation identifying product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Substitution Request Form: Use form acceptable to Architect.
2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:

a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.
b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
c. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.

d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
e. Samples, where applicable or requested.
f. Certificates and qualification data, where applicable or requested.
g. List of similar installations for completed projects, with project names and addresses as well as names and addresses of architects and owners.
h. Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.
i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.
j. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
k. Cost information, including a proposal of change, if any, in the Contract Sum.
l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

    a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
    b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.4 QUALITY ASSURANCE

A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.5 PROCEDURES

A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

1.6 SUBSTITUTIONS

A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.

1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:

a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
b. Substitution request is fully documented and properly submitted.
c. Requested substitution will not adversely affect Contractor's construction schedule.
d. Requested substitution has received necessary approvals of authorities having jurisdiction.
e. Requested substitution is compatible with other portions of the Work.
f. Requested substitution has been coordinated with other portions of the Work.
g. Requested substitution provides specified warranty.
h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

B. Substitutions for Convenience:

1. Architect will consider requests for substitution if received within 60 days after commencement of the Work. Requests received after that time may be considered or rejected at discretion of Architect.

a. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:

1) Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
2) Requested substitution does not require extensive revisions to the Contract Documents.
3) Requested substitution is consistent with the Contract Documents and will produce indicated results.
4) Substitution request is fully documented and properly submitted.
5) Requested substitution will not adversely affect Contractor's construction schedule.

6) Requested substitution has received necessary approvals of authorities having jurisdiction.
7) Requested substitution is compatible with other portions of the Work.
8) Requested substitution has been coordinated with other portions of the Work.
9) Requested substitution provides specified warranty.
10) If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF SECTION 01 25 00

SECTION 01 29 00 - PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.

B. Related Requirements:

1. Document 004373 "Proposed Schedule of Values Form" for requirements for furnishing proposed schedule of values with bid.
2. Section 012600 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
3. Section 013200 "Construction Progress Documentation" for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.

1.2 DEFINITIONS

A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.3 SCHEDULE OF VALUES

A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.

1. Coordinate line items in the schedule of values with items required to be indicated as separate activities in Contractor's construction schedule.
2. Submit the schedule of values to Architect at earliest possible date, but no later than seven days before the date scheduled for submittal of initial Applications for Payment.

B. Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section.

1. Identification: Include the following Project identification on the schedule of values:

a. Project name and location.
b. Owner's name.
c. Owner's Project number.
d. Name of Architect.

e. Architect's Project number.
f. Contractor's name and address.
g. Date of submittal.

2. Arrange schedule of values consistent with format of AIA Document G703.
3. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.

   a. Differentiate between items stored on-site and items stored off-site.

4. Schedule of Values Revisions: Revise the schedule of values when Change Orders or Construction Change Directives result in a change in the Contract Sum. Include at least one separate line item for each Change Order and Construction Change Directive.

1.4 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments, as certified by Architect and paid for by Owner.

B. Payment Application Times: The date for each progress payment is indicated in the Owner/Contractor Agreement. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.

C. Payment Application Times: Submit Application for Payment to Architect by the agreed upon date of the month. The period covered by each Application for Payment is one month, ending on the agreed upon date.

   1. Submit draft copy of Application for Payment seven days prior to due date for review by Architect.

D. Application for Payment Forms: Use AIA Document G702 and AIA Document G703 as form for Applications for Payment.

E. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect will return incomplete applications without action.

   1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
   2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
   3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
   4. Indicate separate amounts for work being carried out under Owner-requested project acceleration.

F. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

    a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
    c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

G. Transmittal: Submit three signed and notarized original copies of each Application for Payment to Architect by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.

1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.

H. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from entities lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.

1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
2. When an application shows completion of an item, submit conditional final or full waivers.
3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
4. Waiver Forms: Submit executed waivers of lien on forms acceptable to Owner.

I. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:

1. List of subcontractors.
2. Schedule of values.
3. Contractor's construction schedule (preliminary if not final).
4. Products list (preliminary if not final).
5. Submittal schedule (preliminary if not final).
6. List of Contractor's staff assignments.
7. List of Contractor's principal consultants.
8. Copies of building permits.
9. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.

10. Initial progress report.

J. Application for Payment at Substantial Completion: After Architect issues the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.

1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
2. This application shall reflect Certificate(s) of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.

K. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:

1. Evidence of completion of Project closeout requirements.
2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
3. Updated final statement, accounting for final changes to the Contract Sum.
4. AIA Document G706.
5. AIA Document G706A.
6. Evidence that claims have been settled.
7. Final meter readings for utilities and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
8. Final liquidated damages settlement statement.
9. Proof that taxes, fees, and similar obligations are paid.
10. Waivers and releases.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF SECTION 01 29 00

SECTION 01 31 00 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative provisions for coordinating construction operations on Project, including, but not limited to, the following:

1. General coordination procedures.
2. Coordination drawings.
3. RFIs.
4. Project meetings.

B. Related Requirements:

1. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
2. Section 017700 "Closeout Procedures" for coordinating closeout of the Contract.

1.2 DEFINITIONS

A. BIM: Building Information Modeling.

B. RFI: Request for Information. Request from Owner, Architect, or Contractor seeking information required by or clarifications of the Contract Documents.

1.3 INFORMATIONAL SUBMITTALS

A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:

1. Name, address, telephone number, and email address of entity performing subcontract or supplying products.
2. Number and title of related Specification Section(s) covered by subcontract.
3. Drawing number and detail references, as appropriate, covered by subcontract.

B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses, cellular telephone numbers, and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1. Post copies of list in Project meeting room, in temporary field office, and in

prominent location in eachbuilt facility. Keep list current at all times.

1.4 GENERAL COORDINATION PROCEDURES

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results, where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.

B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.

C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and scheduled activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of Contractor's construction schedule.
2. Preparation of the schedule of values.
3. Installation and removal of temporary facilities and controls.
4. Delivery and processing of submittals.
5. Progress meetings.
6. Preinstallation conferences.
7. Project closeout activities.
8. Startup and adjustment of systems.

1.5 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely indicated on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.

1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:

a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
b. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
c. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
d. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
e. Indicate required installation sequences.
f. Indicate dimensions shown on Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

1.6 REQUEST FOR INFORMATION (RFI)

A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.

1. Architect will return without response those RFIs submitted to Architect by other entities controlled by Contractor.
2. Coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:

1. Project name.
2. Name of Architect.
3. Date.
4. Name of Contractor.
5. RFI number, numbered sequentially.
6. RFI subject.
7. Specification Section number and title and related paragraphs, as appropriate.
8. Drawing number and detail references, as appropriate.
9. Field dimensions and conditions, as appropriate.
10. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
11. Contractor's signature.
12. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

    a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

C. RFI Forms: Software-generated form with substantially the same content as indicated

above, acceptable to Architect.

1. Attachments shall be electronic files in PDF format.

D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow seven days for Architect's response for each RFI. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.

1. The following Contractor-generated RFIs will be returned without action:

a. Requests for approval of submittals.
b. Requests for approval of substitutions.
c. Requests for approval of Contractor's means and methods.
d. Requests for coordination information already indicated in the Contract Documents.
e. Requests for adjustments in the Contract Time or the Contract Sum.
f. Requests for interpretation of Architect's actions on submittals.
g. Incomplete RFIs or inaccurately prepared RFIs.

2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt by Architect of additional information.
3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."

a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 5 days of receipt of the RFI response.

E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Include the following:

1. Project name.
2. Name and address of Contractor.
3. Name and address of Architect.
4. RFI number, including RFIs that were returned without action or withdrawn.
5. RFI description.
6. Date the RFI was submitted.
7. Date Architect's response was received.

F. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within three days if Contractor disagrees with response.

1.7 DIGITAL PROJECT MANAGEMENT PROCEDURES

A. Use of Architect's Digital Data Files: Digital data files of Architect's BIM model will be provided by Architect for Contractor's use during construction by request.

1. Digital data files may be used by Contractor in preparing coordination drawings, Shop Drawings, and Project Record Drawings.
2. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Contract Drawings.
3. Contractor shall execute a data licensing agreement in the form of AIA Document C106 Digital Data Licensing Agreement.

    a. Subcontractors and other parties granted access by Contractor to Architect's digital data files shall execute a data licensing agreement in the form of AIA Document C106.

B. Web-Based Project Management Software Package: Provide, administer, and use web-based Project management software package for purposes of hosting and managing Project communication and documentation until Final Completion.

1. Web-based Project management software includes, at a minimum, the following features:

    a. Compilation of Project data, including Contractor, subcontractors, Architect, Architect's consultants, Owner, and other entities involved in Project. Include names of individuals and contact information.
    b. Access control for each entity for each workflow process, to determine entity's digital rights to create, modify, view, and print documents.
    c. Document workflow planning, allowing customization of workflow between project entities.
    d. Creation, logging, tracking, and notification for Project communications required in other Specification Sections, including, but not limited to, RFIs, submittals, Minor Changes in the Work, Construction Change Directives, and Change Orders.
    e. Track status of each Project communication in real time, and log time and date when responses are provided.
    f. Procedures for handling PDFs or similar file formats, allowing markups by each entity. Provide security features to lock markups against changes once submitted.
    g. Processing and tracking of payment applications.
    h. Processing and tracking of contract modifications.
    i. Creating and distributing meeting minutes.
    j. Document management for Drawings, Specifications, and coordination drawings, including revision control.
    k. Management of construction progress photographs.
    l. Mobile device compatibility, including smartphones and tablets.

2. Provide seven Project management software user licenses for use of Owner, Owner's Commissioning Authority, Architect, and Architect's consultants. Provide eight hours of software training at Architect's office for web-based Project software users.
3. At completion of Project, provide digital archive in format that is readable by common desktop software applications in format acceptable to Architect. Provide data in locked format to prevent further changes.

C. PDF Document Preparation: Where PDFs are required to be submitted to Architect,

prepare as follows:

1. Assemble complete submittal package into a single indexed file, incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
2. Name file with submittal number or other unique identifier, including revision identifier.
3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

1.8 PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times a minimum of seven days prior to meeting.
2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.

B. Preconstruction Conference: Schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than 15 days after execution of the Agreement.

1. Attendees: Authorized representatives of Owner Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Discuss items of significance that could affect progress, including the following:

    a. Tentative construction schedule.
    b. Phasing.
    c. Critical work sequencing and long lead items.
    d. Designation of key personnel and their duties.
    e. Lines of communications.
    f. Procedures for processing field decisions and Change Orders.
    g. Procedures for RFIs.
    h. Procedures for testing and inspecting.
    i. Procedures for processing Applications for Payment.
    j. Distribution of the Contract Documents.
    k. Submittal procedures.
    l. Preparation of Record Documents.

m. Use of the premises.
n. Work restrictions.
o. Working hours.
p. Owner's occupancy requirements.
q. Responsibility for temporary facilities and controls.
r. Procedures for moisture and mold control.
s. Procedures for disruptions and shutdowns.
t. Construction waste management and recycling.
u. Parking availability.
v. Office, work, and storage areas.
w. Equipment deliveries and priorities.
x. First aid.
y. Security.
z. Progress cleaning.

3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.

C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity when required by other Sections and when required for coordination with other construction.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect of scheduled meeting dates.
2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:

a. Contract Documents.
b. Options.
c. Related RFIs.
d. Related Change Orders.
e. Purchases.
f. Deliveries.
g. Submittals.
h. Possible conflicts.
i. Compatibility requirements.
j. Time schedules.
k. Weather limitations.
l. Manufacturer's written instructions.
m. Warranty requirements.
n. Compatibility of materials.
o. Acceptability of substrates.
p. Temporary facilities and controls.
q. Space and access limitations.
r. Regulations of authorities having jurisdiction.
s. Testing and inspecting requirements.
t. Installation procedures.
u. Coordination with other work.
v. Required performance results.

w. Protection of adjacent work.
x. Protection of construction and personnel.

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

D. Progress Meetings: Conduct progress meetings at regular intervals.

1. Coordinate dates of meetings with preparation of payment requests.
2. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

1) Review schedule for next period.

b. Review present and future needs of each entity present, including the following:

1) Interface requirements.
2) Sequence of operations.
3) Status of submittals.
4) Deliveries.
5) Off-site fabrication.
6) Access.
7) Site use.
8) Temporary facilities and controls.
9) Progress cleaning.
10) Quality and work standards.
11) Status of correction of deficient items.
12) Field observations.
13) Status of RFIs.
14) Status of Proposal Requests.
15) Pending changes.

16) Status of Change Orders.
17) Pending claims and disputes.
18) Documentation of information for payment requests.

4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.

    a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting, where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF SECTION 01 31 00

SECTION 01 32 00 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Contractor's Construction Schedule.
2. Construction schedule updating reports.
3. Daily construction reports.
4. Material location reports.
5. Site condition reports.

B. Related Requirements:

1. Section 012900 "Payment Procedures" for schedule of values and requirements for use of cost-loaded schedule for Applications for Payment.
2. Section 014000 "Quality Requirements" for schedule of tests and inspections.

1.2 DEFINITIONS

A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction Project. Activities included in a construction schedule consume time and resources.

1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
2. Predecessor Activity: An activity that precedes another activity in the network.
3. Successor Activity: An activity that follows another activity in the network.

1.3 INFORMATIONAL SUBMITTALS

A. Format for Submittals: Submit required submittals in the following format:

1. Working electronic copy of schedule file.
2. PDF file.

B. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.

1. Submit a working digital copy of schedule, using software indicated, and labeled to comply with requirements for submittals.

C. Construction Schedule Updating Reports: Submit with Applications for Payment.

D. Site Condition Reports: Submit at time of discovery of differing conditions.

E. Qualification Data: For scheduling consultant.

1.4 QUALITY ASSURANCE

A. Scheduling Consultant Qualifications: An experienced specialist in CPM scheduling and reporting, with capability of producing CPM reports and diagrams within 24 hours of Architect's request.

1.5 COORDINATION

A. Coordinate Contractor's Construction Schedule with the schedule of values, submittal schedule, progress reports, payment requests, and other required schedules and reports.

1. Secure time commitments for performing critical elements of the Work from entities involved.
2. Coordinate each construction activity in the network with other activities, and schedule them in proper sequence.

1.6 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Computer Scheduling Software: Prepare schedules using current version of a program that is capable of managing construction schedules.

B. Time Frame: Extend schedule from date established for commencement of the Work to date of Substantial Completion.

1. Contract completion date to not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

C. Activities: Treat each floor or separate area as a separate numbered activity for each main element of the Work. Comply with the following:

1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.
2. Procurement Activities: Include procurement process activities for the following long lead-time items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
3. Submittal Review Time: Include review and resubmittal times indicated in Section 013300 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with submittal schedule.
4. Startup and Testing Time: Include no fewer than 15 days for startup and testing.
5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.

6. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and Final Completion.

D. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.

1. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:

a. Subcontract awards.
b. Submittals.
c. Purchases.
d. Mockups.
e. Fabrication.
f. Sample testing.
g. Deliveries.
h. Installation.
i. Tests and inspections.
j. Adjusting.
k. Curing.
l. Startup and placement into final use and operation.

E. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and Final Completion.

1. Temporary enclosure and space conditioning.

F. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:

1. Unresolved issues.
2. Unanswered Requests for Information.
3. Rejected or unreturned submittals.
4. Notations on returned submittals.
5. Pending modifications affecting the Work and the Contract Time.

G. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, equipment required to achieve compliance, and date by which recovery will be accomplished.

1.7 GANTT-CHART SCHEDULE REQUIREMENTS

A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's Construction Schedule within 30 days of date established for commencement of the Work.

1. Base schedule on the startup construction schedule and additional information received since the start of Project.

B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.

1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in 10 percent increments within time bar.

1.8 REPORTS

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF SECTION 01 32 00

SECTION 01 32 33 - PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for the following:

1. Preconstruction photographs.
2. Periodic construction photographs.
3. Final Completion construction photographs.

B. Related Requirements:

1. Section 017700 "Closeout Procedures" for submitting photographic documentation as Project Record Documents at Project closeout.
2. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

1.2 INFORMATIONAL SUBMITTALS

A. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.

B. Digital Photographs: Submit image files within three days of taking photographs.

1. Identification: Provide the following information with each image description in file metadata tag:

a. Name of Project.
b. Name and contact information for photographer.
c. Name of Architect.
d. Name of Contractor.
e. Date photograph was taken.
f. Description of location, vantage point, and direction.
g. Unique sequential identifier keyed to accompanying key plan.

1.3 FORMATS AND MEDIA

A. Digital Photographs: Provide color images in JPG format, produced by a digital camera with minimum sensor size of 12 megapixels, and at an image resolution of not less than 3200 by 2400 pixels. Use flash in low light levels or backlit conditions.

B. Digital Images: Submit digital media as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.

C. File Names: Name media files with date andProject area and sequential numbering suffix.

1.4 CONSTRUCTION PHOTOGRAPHS

A. General: Take photographs with maximum depth of field and in focus.

1. Maintain key plan with each set of construction photographs that identifies each photographic location.

B. Preconstruction Photographs: Before commencement of the Work, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect.

1. Flag construction limits before taking construction photographs.
2. Take 20 photographs to show existing conditions adjacent to property before starting the Work.
3. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.

C. Periodic Construction Photographs: Take 20 photographs monthly. Select vantage points to show status of construction and progress since last photographs were taken.

D. Final Completion Construction Photographs: Take 20 photographs after date of Substantial Completion for submission as Project Record Documents. Architect will inform photographer of desired vantage points.

E. Additional Photographs: Architect may request photographs in addition to periodic photographs specified. Additional photographs will be paid for by Change Order and are not included in the Contract Sum.

1. Three days' notice will be given, where feasible.
2. In emergency situations, take additional photographs within 24 hours of request.
3. Circumstances that could require additional photographs include, but are not limited to, the following:

a. Special events planned at Project site.
b. Immediate follow-up when on-site events result in construction damage or losses.
c. Photographs are to be taken at fabrication locations away from Project site. These photographs are not subject to unit prices or unit-cost allowances.
d. Substantial Completion of a major phase or component of the Work.
e. Extra record photographs at time of final acceptance.
f. Owner's request for special publicity photographs.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF SECTION 01 32 33

SECTION 01 33 00 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Submittal schedule requirements.
2. Administrative and procedural requirements for submittals.

B. Related Requirements:

1. Section 012900 "Payment Procedures" for submitting Applications for Payment and the schedule of values.
2. Section 013200 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
3. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
4. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
5. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

1.2 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

1.3 SUBMITTAL SCHEDULE

A. Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and additional time for handling and reviewing submittals required by those corrections.

1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
2. Initial Submittal Schedule: Submit concurrently with startup construction

schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.

3. Final Submittal Schedule: Submit concurrently with the first complete submittal of Contractor's construction schedule.

    a. Submit revised submittal schedule as required to reflect changes in current status and timing for submittals.

4. Format: Arrange the following information in a tabular format:

    a. Scheduled date for first submittal.
    b. Specification Section number and title.
    c. Submittal Category: Action; informational.
    d. Name of subcontractor.
    e. Description of the Work covered.
    f. Scheduled date for Architect's final release or approval.
    g. Scheduled date of fabrication.

1.4 SUBMITTAL FORMATS

A. Submittal Information: Include the following information in each submittal:

1. Project name.
2. Date.
3. Name of Architect.
4. Name of Construction Manager.
5. Name of Contractor.
6. Name of firm or entity that prepared submittal.
7. Names of subcontractor, manufacturer, and supplier.
8. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier and alphanumeric suffix for resubmittals.
9. Category and type of submittal.
10. Submittal purpose and description.
11. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
12. Drawing number and detail references, as appropriate.
13. Indication of full or partial submittal.
14. Location(s) where product is to be installed, as appropriate.
15. Other necessary identification.
16. Remarks.
17. Signature of transmitter.

B. Options: Identify options requiring selection by Architect.

C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Architect on previous submittals. Indicate by highlighting on each

submittal or noting on attached separate sheet.

D. Electronic Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.

1.5 SUBMITTAL PROCEDURES

A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.

1. Email: Prepare submittals as PDF package and transmit to Architect by sending via email. Include PDF transmittal form. Include information in email subject line as requested by Architect.

    a. Architect will return annotated file. Annotate and retain one copy of file as a digital Project Record Document file.

2. Web-Based Project Management Software: Prepare submittals in PDF form, and upload to web-based Project management software website. Enter required data in web-based software site to fully identify submittal.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
4. Coordinate transmittal of submittals for related parts of the Work specified in different Sections, so processing will not be delayed because of need to review submittals concurrently for coordination.

    a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
3. Resubmittal Review: Allow 15 days for review of each resubmittal.
4. Sequential Review: Where sequential review of submittals by Architect's

consultants, Owner, or other parties is indicated, allow 21 days for initial review of each submittal.

5. Concurrent Consultant Review: Where the Contract Documents indicate that submittals may be transmitted simultaneously to Architect and to Architect's consultants, allow 15 days for review of each submittal. Submittal will be returned to Architect before being returned to Contractor.

    a. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Architect.

D. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

1. Note date and content of previous submittal.
2. Note date and content of revision in label or title block, and clearly indicate extent of revision.
3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.

E. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

F. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

1.6 SUBMITTAL REQUIREMENTS

A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
2. Mark each copy of each submittal to show which products and options are applicable.
3. Include the following information, as applicable:

    a. Manufacturer's catalog cuts.
    b. Manufacturer's product specifications.
    c. Standard color charts.
    d. Statement of compliance with specified referenced standards.
    e. Testing by recognized testing agency.
    f. Application of testing agency labels and seals.
    g. Notation of coordination requirements.
    h. Availability and delivery time information.

4. For equipment, include the following in addition to the above, as applicable:

a. Wiring diagrams that show factory-installed wiring.
b. Printed performance curves.
c. Operational range diagrams.
d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.

5. Submit Product Data before Shop Drawings, and before or concurrently with Samples.

B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

a. Identification of products.
b. Schedules.
c. Compliance with specified standards.
d. Notation of coordination requirements.
e. Notation of dimensions established by field measurement.
f. Relationship and attachment to adjoining construction clearly indicated.
g. Seal and signature of professional engineer if specified.

2. Paper Sheet Size: Except for templates, patterns, and similar full-size Drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches.

C. Samples: Submit Samples for review of type, color, pattern, and texture for a check of these characteristics with other materials.

1. Transmit Samples that contain multiple, related components, such as accessories together in one submittal package.
2. Identification: Permanently attach label on unexposed side of Samples that includes the following:

a. Generic description of Sample.
b. Product name and name of manufacturer.
c. Sample source.
d. Number and title of applicable Specification Section.
e. Specification paragraph number and generic name of each item.

3. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.

a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
b. Samples not incorporated into the Work, or otherwise designated as

Owner's property, are the property of Contractor.

4. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units, showing the full range of colors, textures, and patterns available.

    a. Number of Samples: Submit one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.

5. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

    a. Number of Samples: Submit three sets of Samples. Architect will retain two Sample sets; remainder will be returned.

        1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
        2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.

D. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:

1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
2. Manufacturer and product name, and model number if applicable.
3. Number and name of room or space.
4. Location within room or space.

E. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.

F. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.

G. Certificates:

1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
2. Installer Certificates: Submit written statements on manufacturer's letterhead, certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead, certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
4. Material Certificates: Submit written statements on manufacturer's letterhead, certifying that material complies with requirements in the Contract Documents.
5. Product Certificates: Submit written statements on manufacturer's letterhead, certifying that product complies with requirements in the Contract Documents.
6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of AWS B2.1/B2.1M on AWS forms. Include names of firms and personnel certified.

H. Test and Research Reports:

1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for substrate preparation and primers required.
2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:

    a. Name of evaluation organization.
    b. Date of evaluation.

c. Time period when report is in effect.
d. Product and manufacturers' names.
e. Description of product.
f. Test procedures and results.
g. Limitations of use.

1.7 DELEGATED DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Architect.

B. Delegated Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF file paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.

1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

1.8 CONTRACTOR'S REVIEW

A. Action Submittals and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.

B. Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp. Include name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

1. Architect will not review submittals received from Contractor that do not have Contractor's review and approval.

1.9 ARCHITECT'S REVIEW

A. Action Submittals: Architect will review each submittal, indicate corrections or revisions required, and return.

1. PDF Submittals: Architect will indicate, via markup on each submittal, the appropriate action.

2. Submittals by Web-Based Project Management Software: Architect will indicate, on Project management software website, the appropriate action.

B. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.

C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.

D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

E. Architect will return without review submittals received from sources other than Contractor.

F. Submittals not required by the Contract Documents will be returned by Architect without action.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF SECTION 01 33 00

SECTION 01 40 00 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1. Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
3. Requirements for Contractor to provide quality-assurance and quality-control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions of this Section.

C. Related Requirements:

1. Section 012100 "Allowances" for testing and inspection allowances.

1.2 DEFINITIONS

A. Experienced: When used with an entity or individual, "experienced," unless otherwise further described, means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

B. Field Quality-Control Tests and Inspections: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, subcontractor, or sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.

1. Use of trade-specific terminology in referring to a Work result does not require that certain construction activities specified apply exclusively to specific trade(s).

D. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria. Unless otherwise indicated, copies of reports of tests

or inspections performed for other than the Project do not meet this definition.

E. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) in accordance with 29 CFR 1910.7, by a testing agency accredited in accordance with NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

F. Source Quality-Control Tests and Inspections: Tests and inspections that are performed at the source (e.g., plant, mill, factory, or shop).

G. Testing Agency: An entity engaged to perform specific tests, inspections, or both. The term "testing laboratory" has the same meaning as the term "testing agency."

H. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work, to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

I. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work, to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Architect.

1.3 DELEGATED DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.

B. Delegated Design Services Statement: Submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.4 CONFLICTING REQUIREMENTS

A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements is specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, inform the Architect regarding the conflict and obtain clarification prior to proceeding with the Work. Refer conflicting requirements that are different, but apparently equal, to Architect for clarification before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified is the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.5 ACTION SUBMITTALS

A. Mockup Shop Drawings:

1. Indicate manufacturer and model number of individual components.
2. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

1.6 INFORMATIONAL SUBMITTALS

A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.

B. Qualification Data: For Contractor's quality-control personnel.

C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems:

1. Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.
2. Primary wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.

D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:

1. Specification Section number and title.
2. Entity responsible for performing tests and inspections.
3. Description of test and inspection.
4. Identification of applicable standards.
5. Identification of test and inspection methods.
6. Number of tests and inspections required.
7. Time schedule or time span for tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

F. Reports: Prepare and submit certified written reports and documents as specified.

G. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

1.7 REPORTS AND DOCUMENTS

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, telephone number, and email address of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample-taking and testing and inspection.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, telephone number, and email address of technical representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Statement that products at Project site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
6. Statement of whether conditions, products, and installation will affect warranty.
7. Other required items indicated in individual Specification Sections.

C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, telephone number, and email address of factory-authorized service representative making report.
2. Statement that equipment complies with requirements.

3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
4. Statement of whether conditions, products, and installation will affect warranty.
5. Other required items indicated in individual Specification Sections.

1.8 QUALITY ASSURANCE

A. Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that is similar in material, design, and extent to those indicated for this Project.

F. Specialists: Certain Specification Sections require that specific construction activities be performed by entities who are recognized experts in those operations. Specialists will satisfy qualification requirements indicated and engage in the activities indicated.

1. Requirements of authorities having jurisdiction supersede requirements for specialists.

G. Testing and Inspecting Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented in accordance with ASTM E329, and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.

H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect, demonstrate, repair, and perform service on installations of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:

1. Contractor's Responsibilities:

    a. Provide test specimens representative of proposed products and construction.
    b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
    c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
    d. When testing is complete, remove test specimens and test assemblies; do not reuse products on Project.

2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect, with copy to Contractor. Interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from the Contract Documents.

1.9 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.

1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
2. Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor.

B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.

1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
2. Engage a qualified testing agency to perform quality-control services.

    a. Contractor will not employ same entity engaged by Owner, unless agreed

to in writing by Owner.

3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspection will be performed.
4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
5. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

D. Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform duties of Contractor.

E. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."

F. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

G. Contractor's Associated Requirements and Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.

2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
4. Facilities for storage and field curing of test samples.
5. Delivery of samples to testing agencies.
6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
7. Security and protection for samples and for testing and inspection equipment at Project site.

H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents. Coordinate and submit concurrently with Contractor's Construction Schedule. Update and submit with each Application for Payment.

1. Schedule Contents: Include tests, inspections, and quality-control services, including Contractor- and Owner-retained services, commissioning activities, and other Project-required services paid for by other entities.
2. Distribution: Distribute schedule to Owner, Architect, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.10 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Owner will engage a qualified special inspector to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner, and as follows:

1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures, and reviewing the completeness and adequacy of those procedures to perform the Work.
2. Notifying Architect and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect with copy to Contractor and to authorities having jurisdiction.
4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
5. Interpreting tests and inspections, and stating in each report whether tested and inspected Work complies with or deviates from the Contract Documents.
6. Retesting and reinspecting corrected Work.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:

1. Date test or inspection was conducted.
2. Description of the Work tested or inspected.
3. Date test or inspection results were transmitted to Architect.
4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect'sand authorities' having jurisdiction reference during normal working hours.

1. Submit log at Project closeout as part of Project Record Documents.

3.2 REPAIR AND PROTECTION

A. General: On completion of testing, inspection, sample-taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 01 40 00

SECTION 01 42 00 - REFERENCES

PART 1 - GENERAL

1.1 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.

C. "Directed": A command or instruction by Architect. Other terms, including "requested," "authorized," "selected," "required," and "permitted," have the same meaning as "directed."

D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms, including "shown," "noted," "scheduled," and "specified," have the same meaning as "indicated."

E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.

F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.

H. "Provide": Furnish and install, complete and ready for the intended use.

I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.2 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

1. For standards referenced by applicable building codes, comply with dates of standards as listed in building codes.

C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.3 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."

B. Industry Organizations, List: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities in the following list. The information in this list is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. AABC - Associated Air Balance Council; www.aabc.com.
2. AAMA - American Architectural Manufacturers Association; (see FGIA).
3. AAPFCO - Association of American Plant Food Control Officials; www.aapfco.org.
4. AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org.
5. AATCC - American Association of Textile Chemists and Colorists; www.aatcc.org.
6. ABMA - American Bearing Manufacturers Association; www.americanbearings.org.
7. ABMA - American Boiler Manufacturers Association; www.abma.com.
8. ACI - American Concrete Institute; www.concrete.org.
9. ACP - American Clean Power; (Formerly: American Wind Energy Association); www.cleanpower.org.
10. ACPA - American Concrete Pipe Association; www.concretepipe.org.
11. AEIC - Association of Edison Illuminating Companies, Inc. (The); www.aeic.org.
12. AF&PA - American Forest & Paper Association; www.afandpa.org.
13. AGA - American Gas Association; www.aga.org.
14. AHAM - Association of Home Appliance Manufacturers; www.aham.org.
15. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
16. AI - Asphalt Institute; www.asphaltinstitute.org.
17. AIA - American Institute of Architects (The); www.aia.org.
18. AISC - American Institute of Steel Construction; www.aisc.org.
19. AISI - American Iron and Steel Institute; www.steel.org.
20. AITC - American Institute of Timber Construction; (see PLIB).
21. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.
22. AMPP - Association for Materials Protection and Performance; www.ampp.org.
23. ANSI - American National Standards Institute; www.ansi.org.

24. AOSA/SCST - Association of Official Seed Analysts (The)/Society of Commercial Seed Technologists (The); www.analyzeseeds.com.
25. APA - APA - The Engineered Wood Association; www.apawood.org.
26. APA - Architectural Precast Association; www.archprecast.org.
27. API - American Petroleum Institute; www.api.org.
28. ARMA - Asphalt Roofing Manufacturers Association; www.asphaltroofing.org.
29. ASA - Acoustical Society of America; www.acousticalsociety.org.
30. ASCE - American Society of Civil Engineers; www.asce.org.
31. ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (see ASCE).
32. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
33. ASME - ASME International; American Society of Mechanical Engineers (The); www.asme.org.
34. ASSE - ASSE International; (American Society of Sanitary Engineering); www.asse-plumbing.org.
35. ASSP - American Society of Safety Professionals; www.assp.org.
36. ASTM - ASTM International; www.astm.org.
37. ATIS - Alliance for Telecommunications Industry Solutions; www.atis.org.
38. AVIXA - Audiovisual and Integrated Experience Association; www.avixa.org.
39. AWI - Architectural Woodwork Institute; www.awinet.org.
40. AWPA - American Wood Protection Association; www.awpa.com.
41. AWS - American Welding Society; www.aws.org.
42. AWWA - American Water Works Association; www.awwa.org.
43. BHMA - Builders Hardware Manufacturers Association; www.buildershardware.com.
44. BIA - Brick Industry Association (The); www.gobrick.com.
45. BICSI - BICSI, Inc.; www.bicsi.org.
46. BIFMA - Business and Institutional Furniture Manufacturer's Association; www.bifma.org.
47. BISSC - Baking Industry Sanitation Standards Committee; www.bissc.org.
48. CARB - California Air Resources Board; www.arb.ca.gov.
49. CDA - Copper Development Association Inc.; www.copper.org.
50. CFFA - Chemical Fabrics and Film Association, Inc.; www.chemicalfabricsandfilm.com.
51. CFSEI - Cold-Formed Steel Engineers Institute; www.cfsei.org.
52. CGA - Compressed Gas Association; www.cganet.com.
53. CIMA - Cellulose Insulation Manufacturers Association; www.cellulose.org.
54. CISCA - Ceilings & Interior Systems Construction Association; www.cisca.org.
55. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
56. CLFMI - Chain Link Fence Manufacturers Institute; www.chainlinkinfo.org.
57. CMHA - Concrete Masonry & Hardscape Association; (Formerly: National Concrete Masonry Association); www.masonryandhardscapes.org.
58. CPA - Composite Panel Association; www.compositepanel.org.
59. CRI - Carpet and Rug Institute (The); www.carpet-rug.org.
60. CRRC - Cool Roof Rating Council; www.coolroofs.org.
61. CRSI - Concrete Reinforcing Steel Institute; www.crsi.org.
62. CSA - CSA Group; www.csagroup.org.
63. CSI - Cast Stone Institute; www.caststone.org.
64. CSI - Construction Specifications Institute (The); www.csiresources.org.
65. CSSB - Cedar Shake & Shingle Bureau; www.cedarbureau.org.

66. CTA - Consumer Technology Association; www.cta.tech.
67. CTI - Cooling Technology Institute; www.coolingtechnology.org.
68. DASMA - Door and Access Systems Manufacturers Association; www.dasma.com.
69. DHA - Decorative Hardwoods Association; www.decorativehardwoods.org.
70. DHI - Door and Hardware Institute; www.dhi.org.
71. ECIA - Electronic Components Industry Association; www.ecianow.org.
72. EIMA - EIFS Industry Members Association; www.eima.com.
73. EJMA - Expansion Joint Manufacturers Association, Inc.; www.ejma.org.
74. EOS/ESD - EOS/ESD Association, Inc.; Electrostatic Discharge Association; www.esda.org.
75. ESTA - Entertainment Services and Technology Association; www.esta.org.
76. EVO - Efficiency Valuation Organization; www.evo-world.org.
77. FCI - Fluid Controls Institute; www.fluidcontrolsinstitute.org.
78. FGIA - Fenestration and Glazing Industry Alliance; https://fgiaonline.org.
79. FM Approvals - FM Approvals LLC; www.fmapprovals.com.
80. FM Global - FM Global; www.fmglobal.com.
81. FRSA - Florida Roofing and Sheet Metal Contractors Association, Inc.; www.floridaroof.com.
82. FSA - Fluid Sealing Association; www.fluidsealing.com.
83. FSC - Forest Stewardship Council U.S.; www.fscus.org.
84. GA - Gypsum Association; www.gypsum.org.
85. GS - Green Seal; www.greenseal.org.
86. HI - Hydraulic Institute; www.pumps.org.
87. HMMA - Hollow Metal Manufacturers Association; (see NAAMM).
88. IAPSC - International Association of Professional Security Consultants; www.iapsc.org.
89. IAS - International Accreditation Service; www.iasonline.org.
90. ICC - International Code Council; www.iccsafe.org.
91. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
92. ICPA - International Cast Polymer Association (The); www.theicpa.com.
93. ICRI - International Concrete Repair Institute, Inc.; www.icri.org.
94. IEC - International Electrotechnical Commission; www.iec.ch.
95. IEEE SA - IEEE Standards Association; https://standards.ieee.org.
96. IES - Illuminating Engineering Society; www.ies.org.
97. IEST - Institute of Environmental Sciences and Technology; www.iest.org.
98. IGMA - Insulating Glass Manufacturers Alliance; (see FGIA).
99. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.org.
100. ILI - Indiana Limestone Institute of America, Inc.; www.iliai.com.
101. Intertek - Intertek Group; www.intertek.com.
102. ISA - International Society of Automation (The); www.isa.org.
103. ISFA - International Surface Fabricators Association; www.isfanow.org.
104. ISO - International Organization for Standardization; www.iso.org.
105. ITU - International Telecommunication Union; www.itu.int.
106. KCMA - Kitchen Cabinet Manufacturers Association; www.kcma.org.
107. LPI - Lightning Protection Institute; www.lightning.org.
108. MBMA - Metal Building Manufacturers Association; www.mbma.com.
109. MCA - Metal Construction Association; www.metalconstruction.org.
110. MFMA - Maple Flooring Manufacturers Association, Inc.; www.maplefloor.org.
111. MFMA - Metal Framing Manufacturers Association, Inc.; www.metalframingmfg.org.

112. MHI - Material Handling Industry; www.mhi.org.
113. MMPA - Moulding & Millwork Producers Association; www.wmmpa.com.
114. MPI - Master Painters Institute; www.paintinfo.com.
115. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry, Inc.; www.msshq.org.
116. NAAMM - National Association of Architectural Metal Manufacturers; www.naamm.org.
117. NACE - NACE International; (National Association of Corrosion Engineers International); (see AMPP).
118. NADCA - National Air Duct Cleaners Association; www.nadca.com.
119. NAIMA - North American Insulation Manufacturers Association; www.insulationinstitute.org.
120. NALP - National Association of Landscape Professionals; www.landscapeprofessionals.org.
121. NBGQA - National Building Granite Quarries Association, Inc.; www.nbgqa.com.
122. NBI - New Buildings Institute; www.newbuildings.org.
123. NCMA - National Concrete Masonry Association; (see CMHA).
124. NEBB - National Environmental Balancing Bureau; www.nebb.org.
125. NECA - National Electrical Contractors Association; www.necanet.org.
126. NeLMA - Northeastern Lumber Manufacturers Association; www.nelma.org.
127. NEMA - National Electrical Manufacturers Association; www.nema.org.
128. NETA - InterNational Electrical Testing Association; www.netaworld.org.
129. NFHS - National Federation of State High School Associations; www.nfhs.org.
130. NFPA - National Fire Protection Association; www.nfpa.org.
131. NFPA - NFPA International; (see NFPA).
132. NFRC - National Fenestration Rating Council; www.nfrc.org.
133. NGA - National Glass Association; www.glass.org.
134. NHLA - National Hardwood Lumber Association; www.nhla.com.
135. NLGA - National Lumber Grades Authority; www.nlga.org.
136. NOFMA - National Oak Flooring Manufacturers Association; (see NWFA).
137. NOMMA - National Ornamental & Miscellaneous Metals Association; www.nomma.org.
138. NRCA - National Roofing Contractors Association; www.nrca.net.
139. NRMCA - National Ready Mixed Concrete Association; www.nrmca.org.
140. NSF - NSF International; www.nsf.org.
141. NSI - Natural Stone Institute; www.naturalstoneinstitute.org.
142. NSPE - National Society of Professional Engineers; www.nspe.org.
143. NSSGA - National Stone, Sand & Gravel Association; www.nssga.org.
144. NTMA - National Terrazzo & Mosaic Association, Inc. (The); www.ntma.com.
145. NWFA - National Wood Flooring Association; www.nwfa.org.
146. NWRA - National Waste & Recycling Association; www.wasterecycling.org.
147. PCI - Precast/Prestressed Concrete Institute; www.pci.org.
148. PDI - Plumbing & Drainage Institute; www.pdionline.org.
149. PLASA - PLASA; www.plasa.org.
150. PLIB - Pacific Lumber Inspection Bureau; www.plib.org.
151. PVCPA - Uni-Bell PVC Pipe Association; www.uni-bell.org.
152. RCSC - Research Council on Structural Connections; www.boltcouncil.org.
153. RFCI - Resilient Floor Covering Institute; www.rfci.com.
154. RIS - Redwood Inspection Service; (see WWPA).
155. SAE - SAE International; www.sae.org.
156. SCTE - Society of Cable Telecommunications Engineers; www.scte.org.

157. SDI - Steel Deck Institute; www.sdi.org.
158. SDI - Steel Door Institute; www.steeldoor.org.
159. SEFA - Scientific Equipment and Furniture Association (The); www.sefalabs.com.
160. SEI/ASCE - Structural Engineering Institute/American Society of Civil Engineers; (see ASCE).
161. SIA - Security Industry Association; www.securityindustry.org.
162. SJI - Steel Joist Institute; www.steeljoist.org.
163. SMA - Screen Manufacturers Association; www.smainfo.org.
164. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
165. SMPTE - Society of Motion Picture and Television Engineers; www.smpte.org.
166. SPFA - Spray Polyurethane Foam Alliance; www.sprayfoam.org.
167. SPIB - Southern Pine Inspection Bureau; www.spib.org.
168. SPRI - Single Ply Roofing Industry; www.spri.org.
169. SRCC - Solar Rating & Certification Corporation; www.solar-rating.org.
170. SSINA - Specialty Steel Industry of North America; www.ssina.com.
171. SSPC - SSPC: The Society for Protective Coatings; (see AMPP).
172. STI/SPFA - Steel Tank Institute/Steel Plate Fabricators Association; www.steeltank.com.
173. SWI - Steel Window Institute; www.steelwindows.com.
174. SWPA - Submersible Wastewater Pump Association; www.swpa.org.
175. TCA - Tilt-Up Concrete Association; www.tilt-up.org.
176. TCNA - Tile Council of North America, Inc.; www.tcnatile.com.
177. TEMA - Tubular Exchanger Manufacturers Association, Inc.; www.kbcdco.tema.org.
178. TIA - Telecommunications Industry Association; www.tiaonline.org.
179. TMS - The Masonry Society; www.masonrysociety.org.
180. TPI - Truss Plate Institute; www.tpinst.org.
181. TPI - Turfgrass Producers International; www.turfgrasssod.org.
182. TRI - Tile Roofing Industry Alliance; www.tileroofing.org.
183. ULSE - UL Standards & Engagement Inc.; www.ulse.org.
184. UL - UL Solutions Inc.; www.ul.com.
185. USAV - USA Volleyball; www.usavolleyball.org.
186. USGBC - U.S. Green Building Council; www.usgbc.org.
187. USITT - United States Institute for Theatre Technology, Inc.; www.usitt.org.
188. WA - Wallcoverings Association; www.wallcoverings.org.
189. WCLIB - West Coast Lumber Inspection Bureau; (see PLIB).
190. WCMA - Window Covering Manufacturers Association; www.wcmanet.org.
191. WDMA - Window & Door Manufacturers Association; www.wdma.com.
192. WI - Woodwork Institute; www.woodworkinstitute.com.
193. WSRCA - Western States Roofing Contractors Association; www.wsrca.com.
194. WWPA - Western Wood Products Association; www.wwpa.org.

C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities in the following list. This information is believed to be accurate as of the date of the Contract Documents.

1. IAPMO - International Association of Plumbing and Mechanical Officials; www.iapmo.org.

2. ICC - International Code Council; www.iccsafe.org.
3. ICC-ES - ICC Evaluation Service, LLC; www.icc-es.org.

D. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities in the following list. Information is subject to change and is up to date as of the date of the Contract Documents.

1. CPSC - U.S. Consumer Product Safety Commission; www.cpsc.gov.
2. DOC - U.S. Department of Commerce; www.commerce.gov.
3. DOE - U.S. Department of Energy; www.energy.gov.
4. DOJ - U.S. Department of Justice; www.ojp.usdoj.gov
5. DOS - U.S. Department of State; www.state.gov.
6. EPA - United States Environmental Protection Agency; www.epa.gov.
7. FAA - Federal Aviation Administration; www.faa.gov.
8. GPO - U.S. Government Publishing Office; www.gpo.gov.
9. GSA - U.S. General Services Administration; www.gsa.gov.
10. HUD - U.S. Department of Housing and Urban Development; www.hud.gov.
11. LBNL - Lawrence Berkeley National Laboratory; Energy Technologies Area; www.lbl.gov/.
12. NIST - National Institute of Standards and Technology; www.nist.gov.
13. OSHA - Occupational Safety & Health Administration; www.osha.gov.
14. TRB - Transportation Research Board; National Cooperative Highway Research Program; The National Academies; www.trb.org.
15. USDA - U.S. Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; www.ars.usda.gov.
16. USDA - U.S. Department of Agriculture; Rural Utilities Service; www.usda.gov.
17. USP - U.S. Pharmacopeial Convention; www.usp.org.
18. USPS - United States Postal Service; www.usps.com.

E. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the standards and regulations in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. CFR - Code of Federal Regulations; Available from U.S. Government Publishing Office; www.govinfo.gov.
2. FED-STD - Federal Standard; (see FS).
3. FS - Federal Specification; Available from DLA Document Services; www.dsp.dla.mil/Specs-Standards/.

    a. Available from U.S. General Services Administration; www.gsa.gov.
    b. Available from National Institute of Building Sciences/Whole Building Design Guide; www.wbdg.org.

4. USAB - United States Access Board; www.access-board.gov.
5. USATBCB - U.S. Architectural & Transportation Barriers Compliance Board; (see USAB).

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF SECTION 01 42 00

SECTION 01 50 00 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

B. Related Requirements:

1. Section 011000 "Summary" for work restrictions and limitations on utility interruptions.

1.2 USE CHARGES

A. Installation, removal, and use charges for temporary facilities to be included in the Contract Sum unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to, Architect, testing agencies, and authorities having jurisdiction.

B. Water Service: Pay water-service use charges for water used by all entities for construction operations.

C. Electric Power Service: Pay electric-power-service use charges for electricity used by all entities for construction operations.

1.3 INFORMATIONAL SUBMITTALS

A. Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.

B. Implementation and Termination Schedule: Within 15 days of date established for commencement of the Work, submit schedule indicating implementation and termination dates of each temporary utility.

C. Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.

D. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.

E. Moisture- and Mold-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage and mold. Describe

delivery, handling, storage, installation, and protection provisions for materials subject to water absorption or water damage.

1. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and requirements for replacing water-damaged Work.
2. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
3. Indicate methods to be used to avoid trapping water in finished work.

F. Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Include the following:

1. Locations of dust-control partitions at each phase of work.
2. HVAC system isolation schematic drawing.
3. Location of proposed air-filtration system discharge.
4. Waste-handling procedures.
5. Other dust-control measures.

G. Noise and Vibration Control Plan: Identify construction activities that may impact the occupancy and use of existing spaces within the building or adjacent existing buildings, whether occupied by others, or occupied by Owner. Include the following:

1. Methods used to meet the goals and requirements of Owner.
2. Concrete cutting method(s) to be used.
3. Location of construction devices on the site.
4. Show compliance with the use and maintenance of quieted construction devices for the duration of the Project.
5. Indicate activities that may disturb building occupants and that are planned to be performed during non-standard working hours as coordinated with Owner.

1.4 QUALITY ASSURANCE

A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

C. Accessible Temporary Egress: Comply with applicable provisions in ICC A117.1.

1.5 PROJECT CONDITIONS

A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless

of previously assigned responsibilities.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Chain-Link Fencing: Minimum 2-inch, 0.148-inch- thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch- OD line posts and 2-7/8-inch- OD corner and pull posts, with 1-5/8-inch- OD top rails.

B. Portable Chain-Link Fencing: Minimum 2-inch, 0.148-inch- thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch- OD line posts and 2-7/8-inch- OD corner and pull posts, with 1-5/8-inch- OD top and bottom rails. Provide concrete bases for supporting posts.

C. Fencing Windscreen Privacy Screen: Polyester fabric scrim with grommets for attachment to chain-link fence, sized to height of fence, in color selected by Architect from manufacturer's standard colors.

D. Dust-Control Adhesive-Surface Walk-Off Mats: Provide mats, minimum 36 by 60 inches.

E. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

2.2 TEMPORARY FACILITIES

A. Field Offices:

1. Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.

B. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.

1. Store combustible materials apart from building.

2.3 EQUIPMENT

A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.

1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
2. Heating, Cooling, and Dehumidifying Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
3. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air grille in system and remove at end of construction.

C. Air-Filtration Units: Primary and secondary HEPA-filter-equipped portable units with four-stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.

1. Locate facilities to limit site disturbance as specified in Section 011000 "Summary."

B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

A. General: Install temporary service or connect to existing service.

1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.

1. Connect temporary sewers to municipal system as directed by authorities having jurisdiction.

C. Water Service:

1. Install water service and distribution piping in sizes and pressures adequate for construction.
2. Connect to Owner's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.

D. Sanitary Facilities: Provide temporary toilets, wash facilities, safety shower and

eyewash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

1. Use of Permanent Toilets: Use of Owner's existing or new toilet facilities is not permitted.

E. Temporary Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.

1. Provide temporary dehumidification systems when required to reduce ambient and substrate moisture levels to level required to allow installation or application of finishes and their proper curing or drying.

F. Electric Power Service:

1. Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.

a. Install electric power service underground unless otherwise indicated.
b. Connect temporary service to Owner's existing power source, as directed by Owner.

G. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.

1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

3.3 SUPPORT FACILITIES INSTALLATION

A. Comply with the following:

1. Provide construction for temporary field offices, shops, and sheds located within construction area or within 30 feet of building lines that is noncombustible in accordance with ASTM E136. Comply with NFPA 241.
2. Maintain support facilities until Architect schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.

B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas as indicated on Drawings.

1. Provide dust-control treatment that is nonpolluting and nontracking. Reapply

treatment as required to minimize dust.

C. Temporary Use of Planned Permanent Roads and Paved Areas: Locate temporary roads and paved areas in same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.

1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
2. Prepare subgrade and install subbase and base for temporary roads and paved areas in accordance with Section 312000 "Earth Moving."
3. Recondition base after temporary use, including removing contaminated material, regrading, proofrolling, compacting, and testing.
4. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Substantial Completion. Repair hot-mix asphalt base-course pavement before installation of final course in accordance with Section 321216 "Asphalt Paving."

D. Traffic Controls: Comply with requirements of authorities having jurisdiction.

1. Protect existing site improvements to remain, including curbs, pavement, and utilities.
2. Maintain access for fire-fighting equipment and access to fire hydrants.

E. Parking: Provide temporary offsite parking areas for construction personnel.

F. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.

1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
2. Remove snow and ice as required to minimize accumulations.

G. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.

1. Identification Signs: Provide Project identification signs as indicated on Drawings.
2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.

    a. Provide temporary, directional signs for construction personnel and visitors.

3. Maintain and touch up signs, so they are legible at all times.

H. Waste Disposal Facilities:

1. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."
2. Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having

jurisdiction. Comply with progress cleaning requirements in Section 017300 "Execution."

I. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.

1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

J. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.

B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.

1. Comply with work restrictions specified in Section 011000 "Summary."

C. Temporary Erosion and Sedimentation Control:

1. Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, in accordance with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.

a. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant-protection zones.
b. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
c. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
d. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.

E. Tree and Plant Protection:

1. Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root

systems from damage, flooding, and erosion.

F. Site Enclosure Fence: Before construction operations begin, furnish and install site enclosure fence in a manner that will prevent people from easily entering site except by entrance gates.

1. Extent of Fence: As indicated on Drawings.

G. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each workday.

H. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

I. Temporary Egress: Provide temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction. Provide signage directing occupants to temporary egress.

J. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.

1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.

K. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.

1. Prohibit smoking in construction areas. Comply with additional limits on smoking specified in other Sections.
2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition in accordance with requirements of authorities having jurisdiction.
3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign, stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.5 MOISTURE AND MOLD CONTROL

A. Moisture and Mold Protection: Protect stored materials and installed Work in accordance with Moisture and Mold Protection Plan.

B. Exposed Construction Period: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:

1. Protect porous materials from water damage.
2. Protect stored and installed material from flowing or standing water.
3. Keep porous and organic materials from coming into prolonged contact with concrete.
4. Remove standing water from decks.
5. Keep deck openings covered or dammed.

C. Partially Enclosed Construction Period: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:

1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
2. Keep interior spaces reasonably clean and protected from water damage.
3. Periodically collect and remove waste containing cellulose or other organic matter.
4. Discard or replace water-damaged material.
5. Do not install material that is wet.
6. Discard and replace stored or installed material that begins to grow mold.
7. Perform work in a sequence that allows wet materials adequate time to dry before enclosing the material in gypsum board or other interior finishes.

D. Controlled Construction Period: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:

1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
2. Use temporary or permanent HVAC system to control humidity within ranges specified for installed and stored materials.
3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.

    a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for 48 hours are considered defective and require replacing.
    b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for 48 hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Architect.
    c. Remove and replace materials that cannot be completely restored to their manufactured moisture level within 48 hours.

3.6 OPERATION, TERMINATION, AND REMOVAL

A. Maintenance: Maintain facilities in good operating condition until removal.

1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

B. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.

C. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

END OF SECTION 01 50 00

SECTION 01 60 00 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of This Section Includes: Administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.

B. Related Requirements:

1. Section 011000 "Summary" for Contractor requirements related to Owner-furnished products.
2. Section 012100 "Allowances" for products selected under an allowance.
3. Section 012500 "Substitution Procedures" for requests for substitutions.
4. Section 014200 "References" for applicable industry standards for products specified.
5. Section 017700 "Closeout Procedures" for submitting warranties.

1.2 DEFINITIONS

A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
2. New Products: Items that have not previously been incorporated into another project or facility. Salvaged items or items reused from other projects are not considered new products. Items that are manufactured or fabricated to include recycled content materials are considered new products unless otherwise indicated.
3. Comparable Product: Product by named manufacturer that is demonstrated and approved through the comparable product submittal process described in "Comparable Products" Article, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. Published attributes and characteristics of basis-of-design product establish salient characteristics of products.

1. Evaluating Comparable Products: In addition to the basis-of-design product

description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification. Manufacturer's published attributes and characteristics of basis-of-design product also establish salient characteristics of products for purposes of evaluating comparable products.

C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section, provide products qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other requirements of the specifications, select another named product or product from another named manufacturer that does meet the requirements of the specifications; submit a comparable product request or substitution request, if applicable.

D. Comparable Product Request Submittal: An action submittal requesting consideration of a comparable product, including the following information:

1. Identification of basis-of-design product or fabrication or installation method to be replaced, including Specification Section number and title and Drawing numbers and titles.
2. Data indicating compliance with the requirements specified in "Comparable Products" Article.

E. Basis-of-Design Product Specification Submittal: An action submittal complying with requirements in Section 013300 "Submittal Procedures."

F. Substitution: Refer to Section 012500 "Substitution Procedures" for definition and limitations on substitutions.

1.3 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

1. Resolution of Compatibility Disputes between Multiple Contractors:

a. Contractors are responsible for providing products and construction methods compatible with products and construction methods of other contractors.
b. If a dispute arises between the multiple contractors over concurrently selectable but incompatible products, Architect will determine which products will be used.

B. Identification of Products: Except for required labels and operating data, do not attach or imprint manufacturer or product names or trademarks on exposed surfaces of products or equipment that will be exposed to view in occupied spaces or on the

exterior.

1. Labels: Locate required product labels and stamps on a concealed surface, or, where required for observation following installation, on a visually accessible surface that is inconspicuous.
2. Equipment Nameplates: Provide a permanent nameplate on each item of service- or power-operated equipment. Locate on a visually accessible but inconspicuous surface. Include information essential for operation, including the following:

    a. Name of product and manufacturer.
    b. Model and serial number.
    c. Capacity.
    d. Speed.
    e. Ratings.

3. See individual identification Sections in Divisions 21, 22, 23, and 26 for additional equipment identification requirements.

1.4 COORDINATION

A. Modify or adjust affected work as necessary to integrate work of approved comparable products and approved substitutions.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products, using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

B. Delivery and Handling:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to determine compliance with the Contract Documents and that products are undamaged and properly protected.

C. Storage:

1. Provide a secure location and enclosure at Project site for storage of materials and equipment.
2. Store products to allow for inspection and measurement of quantity or counting of units.

3. Store materials in a manner that will not endanger Project structure.
4. Store products that are subject to damage by the elements under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation and with adequate protection from wind.
5. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
7. Protect stored products from damage and liquids from freezing.

1.6 PRODUCT WARRANTIES

A. Warranties specified in other Sections are to be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. Manufacturer's Warranty: Written standard warranty form furnished by individual manufacturer for a particular product and issued in the name of Owner or endorsed by manufacturer to Owner.
2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner and issued in the name of Owner or endorsed by manufacturer to Owner.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.

1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
2. Specified Form: When specified forms are included in the Project Manual, prepare a written document, using indicated form properly executed.
3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time: Comply with requirements in Section 017700 "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been

produced and used successfully in similar situations on other projects.

3. Owner reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Architect will make selection.
5. Descriptive, performance, and reference standard requirements in Specifications establish salient characteristics of products.
6. Or Equal: For products specified by name and accompanied by the term "or equal," "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.

    a. Submit additional documentation required by Architect in order to establish equivalency of proposed products. Unless otherwise indicated, evaluation of "or equal" product status is by Architect, whose determination is final.

B. Product Selection Procedures:

1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.

    a. Sole product may be indicated by the phrase "Subject to compliance with requirements, provide the following."

2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.

    a. Sole manufacturer/source may be indicated by the phrase "Subject to compliance with requirements, provide products by the following."

3. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.

    a. Limited list of products may be indicated by the phrase "Subject to compliance with requirements, provide one of the following."

4. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed or an unnamed product that complies with requirements.

    a. Non-limited list of products is indicated by the phrase "Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following."
    b. Provision of an unnamed product is not considered a substitution, if the product complies with requirements.

5. Limited List of Manufacturers: Where Specifications include a list of

manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.

a. Limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, provide products by one of the following."

6. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed or a product by an unnamed manufacturer that complies with requirements.

a. Non-limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following."
b. Provision of products of an unnamed manufacturer is not considered a substitution, if the product complies with requirements.

7. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications may additionally indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.

a. For approval of products by unnamed manufacturers, comply with requirements in Section 012500 "Substitution Procedures" for substitutions for convenience.

C. Visual Matching Specification: Where Specifications require the phrase "match Architect's sample," provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.

1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012500 "Substitution Procedures" for proposal of product.

D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or a similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 COMPARABLE PRODUCTS

A. Conditions for Consideration of Comparable Products: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests

without action, except to record noncompliance with the following requirements:

1. Evidence that proposed product does not require revisions to the Contract Documents, is consistent with the Contract Documents, will produce the indicated results, and is compatible with other portions of the Work.
2. Detailed comparison of significant qualities of proposed product with those of the named basis-of-design product. Significant product qualities include attributes such as type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other specific features and requirements.
3. Evidence that proposed product provides specified warranty.
4. List of similar installations for completed projects, with project names and addresses and names and addresses of architects and owners, if requested.
5. Samples, if requested.

B. Architect's Action on Comparable Products Submittal: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for a comparable product. Architect will notify Contractor of approval or rejection of proposed comparable product within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

1. Architect's Approval of Submittal: Marked with approval notation from Architect's action stamp. See Section 013300 "Submittal Procedures."
2. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.

C. Submittal Requirements, Single-Step Process: When acceptable to Architect, incorporate specified submittal requirements of individual Specification Section in combined submittal for comparable products. Approval by Architect of Contractor's request for use of comparable product and of individual submittal requirements will also satisfy other submittal requirements.

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 60 00

SECTION 01 73 00 - EXECUTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general administrative and procedural requirements governing execution of the Work, including, but not limited to, the following:

1. Construction layout.
2. Field engineering.
3. Installation.
4. Progress cleaning.
5. Starting and adjusting.
6. Protection of installed construction.
7. Correction of the Work.

B. Related Requirements:

1. Section 013300 "Submittal Procedures" for submitting surveys.
2. Section 017700 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, replacing defective work, and final cleaning.
3. Section 078413 "Penetration Firestopping" for patching penetrations in fire-rated construction.

1.2 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.

B. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For land surveyor.

B. Certified Surveys: Submit two copies signed by professional engineer.

C. Certificates: Submit certificate signed by land surveyor, certifying that location and elevation of improvements comply with requirements.

D. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.

1.4 CLOSEOUT SUBMITTALS

A. Final Property Survey: Submit 5 copies showing the Work performed and record survey data.

1.5 QUALITY ASSURANCE

A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.

B. Professional Engineer Qualifications: Refer to Section 014000 "Quality Requirements."

C. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.

1. Structural Elements: When cutting and patching structural elements, or when encountering the need for cutting and patching of elements whose structural function is not known, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operational elements include the following:

    a. Primary operational systems and equipment.
    b. Fire separation assemblies.
    c. Air or smoke barriers.
    d. Fire-suppression systems.
    e. Plumbing piping systems.
    f. Mechanical systems piping and ducts.
    g. Control systems.
    h. Communication systems.
    i. Fire-detection and -alarm systems.
    j. Conveying systems.
    k. Electrical wiring systems.
    l. Operating systems of special construction.

3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Other construction elements include but are not limited to the following:

    a. Water, moisture, or vapor barriers.
    b. Membranes and flashings.
    c. Exterior curtain-wall construction.
    d. Equipment supports.

e. Piping, ductwork, vessels, and equipment.
f. Noise- and vibration-control elements and systems.

4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

D. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of specified products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Comply with requirements specified in other Sections.

B. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.

1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, gas service piping, and water-service piping; underground electrical services; and other utilities.
2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.

B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
3. Verify compatibility with and suitability of substrates, including compatibility with

existing finishes or primers.

C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:

1. Description of the Work, including Specification Section number and paragraph, and Drawing sheet number and detail, where applicable.
2. List of detrimental conditions, including substrates.
3. List of unacceptable installation tolerances.
4. Recommended corrections.

D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Existing Utility Information: Furnish information to local utility that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Architect in accordance with requirements in Section 013100 "Project Management and Coordination."

3.3 CONSTRUCTION LAYOUT

A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks and existing conditions. If discrepancies are discovered, notify Architect promptly.

B. Engage a land surveyor experienced in laying out the Work, using the following accepted surveying practices:

1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
2. Establish limits on use of Project site.
3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.

4. Inform installers of lines and levels to which they must comply.
5. Check the location, level and plumb, of every major element as the Work progresses.
6. Notify Architect when deviations from required lines and levels exceed allowable tolerances.
7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.

C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.

D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.

E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

3.4 FIELD ENGINEERING

A. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.

1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect before proceeding.
2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.

B. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.

1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.

C. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.

D. Final Property Survey: Engage a land surveyor to prepare a final property survey

showing significant features (real property) for Project. Include on the survey a certification, signed by land surveyor, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.

1. Show boundary lines, monuments, streets, site improvements and utilities, existing improvements and significant vegetation, adjoining properties, acreage, grade contours, and the distance and bearing from a site corner to a legal point.
2. Recording: At Substantial Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

3.5 INSTALLATION

A. Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.

1. Make vertical work plumb, and make horizontal work level.
2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
4. Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches in unoccupied spaces, unless otherwise indicated on Drawings.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions that will ensure satisfactory results as judged by Architect. Maintain conditions required for product performance until Substantial Completion.

D. Conduct construction operations, so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy of type expected for Project.

E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on-site and placement in permanent locations.

F. Tools and Equipment: Select tools or equipment that minimize production of excessive noise levels.

G. Templates: Obtain and distribute to the parties involved templates for Work specified to be factory prepared and field installed. Check Shop Drawings of other portions of the Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions with manufacturer.

1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
2. Allow for building movement, including thermal expansion and contraction.
3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

I. Joints: Make joints of uniform width. Where joint locations in exposed Work are not indicated, arrange joints for the best visual effect, as judged by Architect. Fit exposed connections together to form hairline joints.

3.6 PROGRESS CLEANING

A. Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.

1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F.
3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, in accordance with regulations.

    a. Use containers intended for holding waste materials of type to be stored.

4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.

B. Site: Maintain Project site free of waste materials and debris.

C. Work Areas: Clean areas where Work is in progress to the level of cleanliness necessary for proper execution of the Work.

1. Remove liquid spills promptly.
2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

D. Installed Work: Keep installed work clean. Clean installed surfaces in accordance with written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

F. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 015000 "Temporary Facilities and Controls."

H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

J. Limiting Exposures: Supervise construction operations to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.7 STARTING AND ADJUSTING

A. Coordinate startup and adjusting of equipment and operating components with requirements in Section 019113 "General Commissioning Requirements."

B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

C. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.

D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Manufacturer's Field Service: Comply with qualification requirements in Section 014000 "Quality Requirements."

3.8 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

B. Comply with manufacturer's written instructions for temperature and relative humidity.

3.9 CORRECTION OF THE WORK

A. Repair or remove and replace damaged, defective, or nonconforming Work. Restore damaged substrates and finishes.

1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.

B. Repair Work previously completed and subsequently damaged during construction

period. Repair to like-new condition.

C. Restore permanent facilities used during construction to their specified condition.

D. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.

E. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.

F. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION 01 73 00

SECTION 01 77 00 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for Contract closeout, including, but not limited to, the following:

1. Substantial Completion procedures.
2. Final Completion procedures.
3. List of incomplete items.
4. Submittal of Project warranties.
5. Final cleaning.

B. Related Requirements:

1. Section 012900 "Payment Procedures" for requirements for Applications for Payment for Substantial Completion and Final Completion.
2. Section 013233 "Photographic Documentation" for submitting Final Completion construction photographic documentation.
3. Section 017823 "Operation and Maintenance Data" for additional operation and maintenance manual requirements.
4. Section 017839 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
5. Section 017900 "Demonstration and Training" for requirements to train Owner's maintenance personnel to adjust, operate, and maintain products, equipment, and systems.

1.2 DEFINITIONS

A. List of Incomplete Items: Contractor-prepared list of items to be completed or corrected, prepared for the Architect's use prior to Architect's inspection, to determine if the Work is substantially complete.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of cleaning agent.

B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.

C. Certified List of Incomplete Items: Final submittal at Final Completion.

1.4 CLOSEOUT SUBMITTALS

A. Certificates of Release: From authorities having jurisdiction.

B. Certificate of Insurance: For continuing coverage.

C. Field Report: For pest-control inspection.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Schedule of Maintenance Material Items: For maintenance material submittal items required by other Sections.

1.6 SUBSTANTIAL COMPLETION PROCEDURES

A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's "punch list"), indicating the value of each item on the list and reasons why the Work is incomplete.

B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction, permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
2. Submit closeout submittals specified in other Division 01 Sections, including Project Record Documents, operation and maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.
3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Architect. Label with manufacturer's name and model number.

    a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Owner's signature for receipt of submittals.

5. Submit testing, adjusting, and balancing records.
6. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.

C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Advise Owner of pending insurance changeover requirements.
2. Make final changeover of permanent locks and deliver keys to Owner. Advise

Owner's personnel of changeover in security provisions.
3. Complete startup and testing of systems and equipment.
4. Perform preventive maintenance on equipment used prior to Substantial Completion.
5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 017900 "Demonstration and Training."
6. Advise Owner of changeover in utility services.
7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
9. Complete final cleaning requirements.
10. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.

D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.

1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspection will form the basis of requirements for Final Completion.

1.7 FINAL COMPLETION PROCEDURES

A. Submittals Prior to Final Completion: Before requesting final inspection for determining Final Completion, complete the following:

1. Submit a final Application for Payment in accordance with Section 012900 "Payment Procedures."
2. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list will state that each item has been completed or otherwise resolved for acceptance.
3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
4. Submit pest-control final inspection report.
5. Submit Final Completion photographic documentation.

B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be

completed or corrected before certificate will be issued.

1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.8 LIST OF INCOMPLETE ITEMS

A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

1. Organize list of spaces in sequential order, starting with exterior areas first, listed by room or space number.
2. Organize items applying to each space by major element, including categories for ceilings, individual walls, floors, equipment, and building systems.
3. Include the following information at the top of each page:

    a. Project name.
    b. Date.
    c. Name of Architect.
    d. Name of Contractor.
    e. Page number.

4. Submit list of incomplete items in the following format:

    a. PDF Electronic File: Architect will return annotated file.
    b. Three Paper Copies: Architect will return two copies.

1.9 SUBMITTAL OF PROJECT WARRANTIES

A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial Completion, or when delay in submittal of warranties might limit Owner's rights under warranty.

B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.

C. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.

D. Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.

1. Submit by email to Architect.

E. Warranties in Paper Form:

1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.

F. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 FINAL CLEANING

A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:

    a. Clean Project site of rubbish, waste material, litter, and other foreign substances.
    b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
    c. Rake grounds that are not planted, mulched, or paved to a smooth, even-textured surface.
    d. Remove tools, construction equipment, machinery, and surplus material from Project site.
    e. Remove snow and ice to provide safe access to building.
    f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free

condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.

g. Remove debris and surface dust from limited-access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
h. Clean flooring, removing debris, dirt, and staining; clean in accordance with manufacturer's instructions.
i. Vacuum and mop concrete.
j. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean in accordance with manufacturer's instructions if visible soil or stains remain.
k. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
l. Remove labels that are not permanent.
m. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
n. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
o. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
p. Clean luminaires, lamps, globes, and reflectors to function with full efficiency.
q. Clean strainers.
r. Leave Project clean and ready for occupancy.

C. Pest Control: Comply with pest control requirements in Section 015000 "Temporary Facilities and Controls." Prepare written report.

D. Construction Waste Disposal: Comply with waste-disposal requirements in Section 015000 "Temporary Facilities and Controls."

3.2 CORRECTION OF THE WORK

A. Complete repair and restoration operations required by "Correction of the Work" Article in Section 017300 "Execution" before requesting inspection for determination of Substantial Completion.

END OF SECTION 01 77 00

SECTION 01 78 23 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

1. Operation and maintenance documentation directory manuals.
2. Emergency manuals.
3. Systems and equipment operation manuals.
4. Systems and equipment maintenance manuals.
5. Product maintenance manuals.

B. Related Requirements:

1. Section 011200 "Multiple Contract Summary" for coordinating operation and maintenance manuals covering the Work of multiple contracts.
2. Section 013300 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
3. Section 018626 "Electrical Performance Requirements" for requirements for Electrical Preventative Maintenance (EPM) Program binders that form part of the operation and maintenance data of this Section and include additional requirements for operation, maintenance, and emergency procedures, for electrical systems and equipment.
4. Section 019113 "General Commissioning Requirements" for verification and compilation of data into operation and maintenance manuals.

1.2 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.3 CLOSEOUT SUBMITTALS

A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.

1. Architect will comment on whether content of operation and maintenance submittals is acceptable.
2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

B. Format: Submit operation and maintenance manuals in the following format:

1. Submit by email to Architect. Enable reviewer comments on draft submittals.
2. Submit three paper copies. Architect will return two copies.

C. Initial Manual Submittal: Submit draft copy of each manual at least 30 days before commencing demonstration and training. Architect will comment on whether general scope and content of manual are acceptable.

D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Architect will return copy with comments.

1. Correct or revise each manual to comply with Architect's comments. Submit copies of each corrected manual within 15 days of receipt of Architect's comments and prior to commencing demonstration and training.

E. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

1.4 FORMAT OF OPERATION AND MAINTENANCE MANUALS

A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.

1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

B. Manuals, Paper Copy: Submit manuals in the form of hard-copy, bound and labeled volumes.

1. Binders: Heavy-duty, three-ring, vinyl-covered, post-type binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
b. Identify each binder on front and spine, with printed title "OPERATION

AND MAINTENANCE MANUAL," Project title or name, subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.

2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment. Enclose title pages and directories in clear plastic sleeves.
4. Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.
5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

    a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
    b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

1.5 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual to contain the following materials, in the order listed:

1. Title page.
2. Table of contents.
3. Manual contents.

B. Title Page: Include the following information:

1. Subject matter included in manual.
2. Name and address of Project.
3. Name and address of Owner.
4. Date of submittal.
5. Name and contact information for Contractor.
6. Name and contact information for Construction Manager.
7. Name and contact information for Architect.
8. Name and contact information for Commissioning Authority.
9. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
10. Cross-reference to related systems in other operation and maintenance manuals.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation in accordance with ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

1.6 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY MANUAL

A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals. List items and their location to facilitate ready access to desired information. Include the following:

1. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
2. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
3. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

1.7 EMERGENCY MANUALS

A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.

B. Content: Organize manual into a separate section for each of the following:

1. Type of emergency.
2. Emergency instructions.
3. Emergency procedures.

C. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:

1. Fire.
2. Flood.
3. Gas leak.

4. Water leak.
5. Power failure.
6. Water outage.
7. System, subsystem, or equipment failure.
8. Chemical release or spill.

D. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

E. Emergency Procedures: Include the following, as applicable:

1. Instructions on stopping.
2. Shutdown instructions for each type of emergency.
3. Operating instructions for conditions outside normal operating limits.
4. Required sequences for electric or electronic systems.
5. Special operating instructions and procedures.

1.8 SYSTEMS AND EQUIPMENT OPERATION MANUALS

A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:

1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
2. Performance and design criteria if Contractor has delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

C. Descriptions: Include the following:

1. Product name and model number. Use designations for products indicated on

Contract Documents.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

D. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

F. Piped Systems: Diagram piping as installed, and identify color coding where required for identification.

1.9 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds as described below.

C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents.

For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

    a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training video recording, if available.

F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

I. Warranties and Bonds: Include copies of warranties and bonds and lists of

circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.

1. Do not use original project record documents as part of maintenance manuals.

1.10 PRODUCT MAINTENANCE MANUALS

A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Product Information: Include the following, as applicable:

1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.

E. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF SECTION 01 78 23

SECTION 01 78 39 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for Project Record Documents, including the following:

1. Record Drawings.
2. Record Product Data.
3. Miscellaneous record submittals.

B. Related Requirements:

1. Section 011200 "Multiple Contract Summary" for coordinating Project Record Documents covering the Work of multiple contracts.
2. Section 017300 "Execution" for final property survey.
3. Section 017700 "Closeout Procedures" for general closeout procedures.
4. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.2 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:

1. Number of Copies: Submit one set(s) of marked-up record prints.
2. Number of Copies: Submit copies of Record Drawings as follows:

a. Initial Submittal:

1) Submit one paper-copy set(s) of marked-up record prints.
2) Submit PDF electronic files of scanned record prints and one set(s) of file prints.
3) Submit Record Digital Data Files and one set(s) of plots.
4) Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.

b. Final Submittal:

1) Submit one paper-copy set(s) of marked-up record prints.
2) Submit Record Digital Data Files and one set(s) of Record Digital Data File plots.
3) Plot each drawing file, whether or not changes and additional information were recorded.

B. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.

1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.

C. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit annotated PDF electronic files and directories of each submittal.

D. Reports: Submit written report weeklyindicating items incorporated into Project Record Documents concurrent with progress of the Work, including revisions, concealed conditions, field changes, product selections, and other notations incorporated.

1.3 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.

1. Preparation: Mark record prints to show the actual installation, where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

    a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
    b. Accurately record information in an acceptable drawing technique.
    c. Record data as soon as possible after obtaining it.
    d. Record and check the markup before enclosing concealed installations.
    e. Cross-reference record prints to corresponding photographic documentation.

2. Content: Types of items requiring marking include, but are not limited to, the following:

    a. Dimensional changes to Drawings.
    b. Revisions to details shown on Drawings.
    c. Depths of foundations.
    d. Locations and depths of underground utilities.
    e. Revisions to routing of piping and conduits.
    f. Revisions to electrical circuitry.
    g. Actual equipment locations.
    h. Duct size and routing.
    i. Locations of concealed internal utilities.
    j. Changes made by Change Order or Construction Change Directive.
    k. Changes made following Architect's written orders.
    l. Details not on the original Contract Drawings.
    m. Field records for variable and concealed conditions.
    n. Record information on the Work that is shown only schematically.

3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up

record prints.

4. Mark record prints with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
5. Mark important additional information that was either shown schematically or omitted from original Drawings.
6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize record prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Format: Annotated PDF electronic file.
3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
4. Identification: As follows:

    a. Project name.
    b. Date.
    c. Designation "PROJECT RECORD DRAWINGS."
    d. Name of Architect.
    e. Name of Contractor.

1.4 RECORD PRODUCT DATA

A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and revisions to Project Record Documents as they occur; do not wait until end of Project.

B. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
3. Note related Change Orders and Record Drawings where applicable.

C. Format: Submit Record Product Data as annotated PDF electronic file.

1. Include Record Product Data directory organized by Specification Section number and title, electronically linked to each item of Record Product Data.

1.5 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

B. Format: Submit miscellaneous record submittals as PDF electronic file.

1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

1.6 MAINTENANCE OF RECORD DOCUMENTS

A. Maintenance of Record Documents: Store Record Documents in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Architect's reference during normal working hours.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF SECTION 01 78 39

SECTION 01 79 00 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:

1. Instruction in operation and maintenance of systems, subsystems, and equipment.
2. Demonstration and training video recordings.

1.2 INFORMATIONAL SUBMITTALS

A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.

1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.

B. Qualification Data: For facilitator.

C. Attendance Record: For each training module, submit list of participants and length of instruction time.

D. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

1.3 CLOSEOUT SUBMITTALS

A. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module.

1. Identification: On each copy, provide an applied label with the following information:

a. Name of Project.
b. Name and address of videographer.
c. Name of Architect.
d. Name of Construction Manager.
e. Name of Contractor.
f. Date of video recording.

2. At completion of training, submit complete training manual(s) for Owner's use prepared in same PDF file format required for operation and maintenance manuals specified in Section 017823 "Operation and Maintenance Data."

1.4 QUALITY ASSURANCE

A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.

B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 "Quality Requirements," experienced in operation and maintenance procedures and training.

1.5 COORDINATION

A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.

B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data have been reviewed and approved by Architect.

1.6 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:

1. Basis of System Design, Operational Requirements, and Criteria: Include the following:

    a. System, subsystem, and equipment descriptions.
    b. Performance and design criteria if Contractor is delegated design responsibility.
    c. Operating standards.
    d. Regulatory requirements.
    e. Equipment function.

f. Operating characteristics.
g. Limiting conditions.
h. Performance curves.

2. Documentation: Review the following items in detail:

a. Emergency manuals.
b. Systems and equipment operation manuals.
c. Systems and equipment maintenance manuals.
d. Product maintenance manuals.
e. Project Record Documents.
f. Identification systems.
g. Warranties and bonds.
h. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:

a. Instructions on meaning of warnings, trouble indications, and error messages.
b. Instructions on stopping.
c. Shutdown instructions for each type of emergency.
d. Operating instructions for conditions outside of normal operating limits.
e. Sequences for electric or electronic systems.
f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:

a. Startup procedures.
b. Equipment or system break-in procedures.
c. Routine and normal operating instructions.
d. Regulation and control procedures.
e. Control sequences.
f. Safety procedures.
g. Instructions on stopping.
h. Normal shutdown instructions.
i. Operating procedures for emergencies.
j. Operating procedures for system, subsystem, or equipment failure.
k. Seasonal and weekend operating instructions.
l. Required sequences for electric or electronic systems.
m. Special operating instructions and procedures.

5. Adjustments: Include the following:

a. Alignments.
b. Checking adjustments.
c. Noise and vibration adjustments.
d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:

a. Diagnostic instructions.

b. Test and inspection procedures.

7. Maintenance: Include the following:

a. Inspection procedures.
b. Types of cleaning agents to be used and methods of cleaning.
c. List of cleaning agents and methods of cleaning detrimental to product.
d. Procedures for routine cleaning.
e. Procedures for preventive maintenance.
f. Procedures for routine maintenance.
g. Instruction on use of special tools.

8. Repairs: Include the following:

a. Diagnosis instructions.
b. Repair instructions.
c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
d. Instructions for identifying parts and components.
e. Review of spare parts needed for operation and maintenance.

1.7 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 "Operation and Maintenance Data."

B. Set up instructional equipment at instruction location.

1.8 INSTRUCTION

A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.

B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

1. Owner will furnish Contractor with names and positions of participants.

C. Scheduling: Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

1. Schedule training with Owner, through Architect, with at least seven days' advance notice.

D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

E. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of an oral performance-based test.

F. Cleanup: Collect used and leftover educational materials and remove from Project site. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF SECTION 01 79 00

SECTION 03 10 00 - CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Form-facing materials.

B. Related Requirements:

1. Section 321313 "Concrete Paving" for formwork related to concrete pavement and walks.
2. Section 321316 "Decorative Concrete Paving" for formwork related to decorative concrete pavement and walks.

1.2 DEFINITIONS

A. Form-Facing Material: The temporary form materials that come in direct contact with the concrete as part of the formwork components in supporting the concrete while the concrete is setting and gaining sufficient strength to be self-supporting. The most common materials are steel, aluminum, and wood.

B. Form Lining: Materials used to line the concreting face of formwork to impart a smooth or patterned finish to the concrete surface, to absorb moisture from the concrete, or to apply a set-retarding chemical to the formed surface of the concrete.

C. Formwork: The total system of support of freshly placed concrete, including the mold or sheathing that contacts the concrete, as well as supporting members, hardware, and necessary bracing.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1. Review the following:

a. Special inspection and testing and inspecting agency procedures for field quality control.
b. Construction, movement, contraction, and isolation joints
c. Forms and form-removal limitations.
d. Shoring and reshoring procedures.
e. Anchor rod and anchorage device installation tolerances.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.

C. Shop Drawings: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.

1. For exposed vertical concrete walls, indicate dimensions and form tie locations.
2. Indicate dimension and locations of construction and movement joints required to construct the structure in accordance with ACI 301.

a. Location of construction joints is subject to approval of Architect.

3. Indicate location of waterstops.
4. Indicate form liner layout and form line termination details.
5. Indicate proposed schedule and sequence of stripping of forms, shoring removal, and reshoring installation and removal.
6. Indicate layout of insulating concrete forms, dimensions, course heights, form types, and details.

D. Samples:

1. For waterstops.
2. For Form Liners: 12- by 12-inch sample, indicating texture.

1.5 INFORMATIONAL SUBMITTALS

A. Research Reports: For insulating concrete forms indicating compliance with ICC's Acceptance Criteria AC353.

B. Field quality-control reports.

C. Minutes of preinstallation conference.

D. Qualification Statements: For testing and inspection agency.

1.6 QUALITY ASSURANCE

A. Testing and Inspection Agency Qualifications: An independent agency,[**acceptable to authorities having jurisdiction,**] qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

B. Mockups: Formed surfaces to demonstrate typical joints, surface finish, texture, tolerances, and standard of workmanship.

1. Build panel approximately [**100 sq. ft.**]<**Insert area**> in the location indicated or, if not indicated, as directed by Architect.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Form Liners: Store form liners under cover to protect from sunlight.

B. Insulating Concrete Forms: Store forms off ground and under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

C. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.

1. Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."
2. Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.

a. For architectural concrete specified in Section 033300 "Architectural Concrete," limit deflection of form-facing material, studs, and walers to 0.0025 times their respective clear spans (L/400).

B. Design, engineer, erect, shore, brace, and maintain insulating concrete forms in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.

1. Design cross ties to transfer the effects of the following loads to the cast-in-place concrete core:

a. Wind Loads: As indicated on Drawings.

1) Horizontal Deflection Limit: Not more than [**1/240**][**1/360**][**1/600**][**1/720**]<**Insert ratio**> of the wall height.

2.2 FORM-FACING MATERIALS

A. As-Cast Surface Form-Facing Material:

1. Provide continuous, true, and smooth concrete surfaces.
2. Furnish in largest practicable sizes to minimize number of joints.
3. Acceptable Materials: As required to comply with Surface Finish designations specified in Section 033000 "Cast-in-Place Concrete, and as follows:

    a. Plywood, metal, or other approved panel materials.
    b. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

        1) APA HDO (high-density overlay).
        2) APA MDO (medium-density overlay); mill-release agent treated and edge sealed.
        3) APA Structural 1 Plyform, B-B or better; mill oiled and edge sealed.
        4) APA Plyform Class I, B-B or better; mill oiled and edge sealed.

B. Concealed Surface Form-Facing Material: Lumber, plywood, metal, plastic, or another approved material.

1. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that produce surfaces [**with gradual or abrupt irregularities**][**without spiral or vertical seams**] not exceeding specified formwork surface class.

1. Provide forms with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation, with [**straight**][**or**][**tapered**] end forms.

E. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.

2.3 RELATED MATERIALS

A. Reglets: Fabricate reglets of not less than 0.022-inch- thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

B. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

D. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

E. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
2. Form release agent for form liners to be acceptable to form liner manufacturer.

F. Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

G. Sealant: One-part moisture cure silicone sealant used with form liners.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMWORK

A. Comply with ACI 301.

B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 and to comply with the Surface Finish designations specified in Section 033000 "Cast-in-Place Concrete" for as-cast finishes[.][**and Section 033300 "Architectural Concrete."**]

C. Limit concrete surface irregularities as follows:

1. Surface Finish-1.0: ACI 117 Class D, 1 inch.
2. Surface Finish-2.0: ACI 117 Class B, 1/4 inch.
3. Surface Finish-3.0: ACI 117 Class A, 1/8 inch.

D. Construct forms tight enough to prevent loss of concrete mortar.

1. Minimize joints.
2. Exposed Concrete: Symmetrically align joints in forms.

E. Construct removable forms for easy removal without hammering or prying against concrete surfaces.

1. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.
2. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

3. Install keyways, reglets, recesses, and other accessories, for easy removal.

F. Do not use rust-stained, steel, form-facing material.

G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.

1. Provide and secure units to support screed strips
2. Use strike-off templates or compacting-type screeds.

H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.

1. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
2. Locate temporary openings in forms at inconspicuous locations.

I. [**Chamfer**][**Do not chamfer**] exterior corners and edges of permanently exposed concrete.

J. At construction joints, overlap forms onto previously placed concrete not less than 12 inches.

K. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.

1. Determine sizes and locations from trades providing such items.
2. Obtain written approval of Architect prior to forming openings not indicated on Drawings.

L. Form Liners: Install per manufacturer's written installation instructions and recommended tolerances.

M. Construction and Movement Joints:

1. Construct joints true to line with faces perpendicular to surface plane of concrete.
2. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
3. Place joints perpendicular to main reinforcement.
4. Locate joints for beams, slabs, joists, and girders in the middle third of spans.

    a. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.

5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
6. Space vertical joints in walls [**as indicated on Drawings**]<**Insert spacing**>.

    a. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

N. Provide temporary ports or openings in formwork where required to facilitate cleaning

and inspection.

1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
2. Close temporary ports and openings with tight-fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.

O. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

P. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

Q. Coat contact surfaces of forms with form-release agent, in accordance with manufacturer's written instructions, before placing reinforcement.

3.2 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete.

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
4. Install dovetail anchor slots in concrete structures, as indicated on Drawings.
5. Clean embedded items immediately prior to concrete placement.

3.3 REMOVING AND REUSING FORMS

A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for [**24**]<**Insert number**> hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved[**at least 70 percent of**] its 28-day design compressive strength.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work.

1. Split, frayed, delaminated, or otherwise damaged form-facing material are

unacceptable for exposed surfaces.
2. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints.

1. Align and secure joints to avoid offsets.
2. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 INSTALLATION OF SHORING AND RESHORING

A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.

1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.

C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a [**special inspector**][**and**][**qualified testing and inspecting agency**] to perform field tests and inspections and prepare test reports.

B. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

C. Inspections:

1. Inspect formwork for shape, location, and dimensions of the concrete member being formed.
2. Inspect insulating concrete forms for shape, location, and dimensions of the concrete member being formed.

D. Prepare test and inspection reports.

END OF SECTION 03 10 00

SECTION 03 20 00 - CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel reinforcement bars.
2. Welded-wire reinforcement.

B. Related Requirements:

1. Section 033816 "Unbonded Post-Tensioned Concrete" for reinforcing related to post-tensioned concrete.
2. Section 034100 "Precast Structural Concrete" for reinforcing used in precast structural concrete.
3. Section 034500 "Precast Architectural Concrete" for reinforcing used in precast architectural concrete.
4. Section 321313 "Concrete Paving" for reinforcing related to concrete pavement and walks.
5. Section 321316 "Decorative Concrete Paving" for reinforcing related to decorative concrete pavement and walks.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**]<**Insert location**>.

1. Review the following:

a. Special inspection and testing and inspecting agency procedures for field quality control.
b. Construction contraction and isolation joints.
c. Steel-reinforcement installation.

1.3 ACTION SUBMITTALS

1. Each type of steel reinforcement.
2. Epoxy repair coating.
3. Zinc repair material.
4. Bar supports.
5. Mechanical splice couplers.

B. Sustainable Design Submittals:

1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material.

Include distance to Project, means of transportation, and cost for each regional material.
2. Environmental Product Declaration: For each product.
3. Third-Party Certifications: For each product.
4. Third-Party Certified Life Cycle Assessment: For each product.

C. Shop Drawings: Comply with ACI SP-066:

1. Include placing drawings that detail fabrication, bending, and placement.
2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.
3. For structural thermal break insulated connection system, indicate general configuration, insulation dimensions, tension bars, compression pads, shear bars, and dimensions.

D. Construction Joint Layout: Indicate proposed construction joints required to build the structure.

1. Location of construction joints is subject to approval of Architect.

E. Delegated Design Submittal: For structural thermal break insulated connection system, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For [**delegated design engineer**][**testing and inspection agency**].

B. Delegated Design Engineer Qualifications: Include the following:

1. Experience providing delegated design engineering services of the type indicated.
2. Documentation that delegated design engineer is licensed in the [**jurisdiction**][**state**] in which Project is located.

C. Welding certificates.

1. Reinforcement To Be Welded: Welding procedure specification in accordance with AWS D1.4/D1.4M.

D. Material Certificates: For each of the following, signed by manufacturers:

1. Epoxy-Coated Reinforcement: CRSI's "Epoxy Coating Plant Certification."
2. Dual-Coated Reinforcement: CRSI's "Epoxy Coating Plant Certification."

E. Material Test Reports: For the following, from a qualified testing agency:

1. Steel Reinforcement:

a. For reinforcement to be welded, mill test analysis for chemical composition and carbon equivalent of the steel in accordance with ASTM A706/A706M.

2. Mechanical splice couplers.

F. Field quality-control reports.

G. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency,[**acceptable to authorities having jurisdiction,**] qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.4/D 1.4M.

C. Mockups: Reinforcing for cast-concrete formed surfaces, to demonstrate tolerances and standard of workmanship.

1. Build panel approximately [**100 sq. ft. for formed surface**]<**Insert area**> in the location indicated on Drawings or, if not indicated, as directed by Architect.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage[**and to avoid damaging coatings on steel reinforcement**].

1. Store reinforcement to avoid contact with earth.
2. Do not allow epoxy-coated reinforcement to be stored outdoors for more than 60 days without being stored under an opaque covering.
3. Do not allow dual-coated reinforcement to be stored outdoors for more than 60 days without being stored under an opaque covering.
4. Do not allow stainless steel reinforcement to come into contact with uncoated reinforcement.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design structural thermal break insulated connection system, including attachment to building construction.

B. Structural Performance of Structural Thermal Break Insulating Connection System:

Structural thermal break insulated connection system to withstand the following loads and stresses:

1. Dead Loads: As indicated on Drawings.
    a. Shear Load: As indicated on Drawings.
    b. Bending Moment: As indicated on Drawings.
2. Live Loads: As indicated on Drawings.
    a. Shear Load: As indicated on Drawings.
    b. Bending Moment: As indicated on Drawings.

C. Seismic Performance of Structural Thermal Break Insulated Connection System: Structural thermal break Insulated connection system to withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]<**Insert requirement**>.

1. Component Importance Factor: <**Insert requirement**>.

2.2 STEEL REINFORCEMENT

1. Regional Materials: Steel shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

B. Reinforcing Bars: ASTM A615/A615M, [**Grade 60**][**Grade 75**][**Grade 80**][**Grade 100**], deformed.

C. Low-Alloy Steel Reinforcing Bars: ASTM A706/A706M, deformed.

D. Headed-Steel Reinforcing Bars: ASTM A970/A970M.

E. Galvanized Reinforcing Bars:

1. Steel Bars: [**ASTM A615/A615M, Grade 60**][**ASTM A615/A615M, Grade 75**][**ASTM A615/A615M, Grade 80**][**ASTM A615/A615M, Grade 100**][**ASTM A706/A706M**], deformed bars.
2. Zinc Coating: ASTM A767/A767M, [**Class I**][**Class II**] zinc coated after fabrication and bending.

F. Epoxy-Coated Reinforcing Bars:

1. Steel Bars: [**ASTM A615/A615M, Grade 60**][**ASTM A615/A615M, Grade 75**][**ASTM A615/A615M, Grade 80**][**ASTM A615/A615M, Grade 100**][**ASTM A706/A706M**], deformed bars.
2. Epoxy Coating: [**ASTM A775/A775M**][**or**][**ASTM A934/A934M**] with less than 2 percent damaged coating in each 12-inch bar length.

G. Dual-Coated Reinforcing Bars: ASTM A1055/A1055M.

1. Steel Bars: [**ASTM A615/A615M, Grade 60**][**ASTM A615/A615M, Grade 75**][**ASTM A615/A615M, Grade 80**][**ASTM A615/A615M, Grade 100**][**ASTM A706/A706M**], deformed bars.
2. Zinc Coating: ASTM A1055/A1055M [**Type I**][**Type II**].
3. Epoxy Coating: [**ASTM A775/A775M**][**or**][**ASTM A934/A934M**] with less than 2 percent damaged coating in each 12-inch bar length.

H. Stainless Steel Reinforcing Bars: ASTM A955/A955M, [**Grade 60**][**Grade 75**], [**Type 304**][**Type 316L**], deformed.

I. Steel Bar Mats: ASTM A184/A184M, fabricated from [**ASTM A615/A615M, Grade 60**][**ASTM A615/A615M, Grade 40**][**ASTM A706/A706M**], deformed bars, assembled with clips.

J. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.

K. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.

L. Galvanized-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from galvanized-steel wire into flat sheets.

M. Epoxy-Coated Welded-Wire Reinforcement: ASTM A884/A884M, Class A coated, Type 1, [**plain**][**deformed**] steel.

2.3 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.

B. Epoxy-Coated Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, ASTM A775/A775M epoxy coated.

C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.

1. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

    a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.
    b. For epoxy-coated reinforcement, use CRSI Class 1A epoxy-coated or other dielectric-polymer-coated wire bar supports.
    c. For dual-coated reinforcement, use CRSI Class 1A epoxy-coated or other dielectric-polymer-coated wire bar supports.
    d. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.
    e. For stainless steel reinforcement, use CRSI Class 1 plastic-protected steel

wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.

D. Mechanical Splice Couplers: ACI 318 [**Type 1**][**Type 2**], same material of reinforcing bar being spliced; [**compression-only type**][**tension-compression type**][**dowel-bar type**][**mechanical-lap type**].

E. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch in diameter.

1. Finish: [**Plain**][**Galvanized**][**ASTM A884/A884M, Class A, Type 1, epoxy coated, with less than 2 percent damaged coating in each 12-inch wire length**].

F. Stainless Steel Tie Wire: ASTM A1022/A1022M, not less than 0.0508 inch in diameter.

G. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A775/A775M.

H. Zinc Repair Material: ASTM A780/A780M.

2.4 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection of In-Place Conditions:

1. Do not cut or puncture vapor retarder.
2. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

3.2 INSTALLATION OF STEEL REINFORCEMENT

A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.

B. Accurately position, support, and secure reinforcement against displacement.

1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
2. Do not tack weld crossing reinforcing bars.

C. Preserve clearance between bars of not less than 1 inch, not less than one bar

diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.

D. Provide concrete coverage in accordance with ACI 318.

E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

F. Splices: Lap splices as indicated on Drawings.

1. Bars indicated to be continuous, and all vertical bars to be lapped not less than 36 bar diameters at splices, or 24 inches, whichever is greater.
2. Stagger splices in accordance with ACI 318.
3. Mechanical Splice Couplers: Install in accordance with manufacturer's instructions.
4. Weld reinforcing bars in accordance with AWS D1.4/D 1.4M, where indicated on Drawings.

G. Install structural thermal break insulated connection system in accordance with manufacturer's instructions.

H. Install welded-wire reinforcement in longest practicable lengths.

1. Support welded-wire reinforcement in accordance with CRSI "Manual of Standard Practice."

a. For reinforcement less than W4.0 or D4.0, continuous support spacing to not exceed 12 inches.

2. Lap edges and ends of adjoining sheets at least one wire spacing plus 2 inches for plain wire and 8 inches for deformed wire.
3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
4. Lace overlaps with wire.

I. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating in accordance with ASTM D3963/D3963M.

J. Dual-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating in accordance with ASTM D3963/D3963M.

K. Zinc-Coated Reinforcement: Repair cut and damaged zinc coatings with zinc repair material in accordance with ASTM A780/A780M.

3.3 JOINTS

A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement.
2. Continue reinforcement across construction joints unless otherwise indicated.
3. Do not continue reinforcement through sides of strip placements of floors and slabs.

B. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length, to prevent concrete bonding to one side of joint.

3.4 INSTALLATION TOLERANCES

A. Comply with ACI 117.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a [**special inspector**][**and**][**qualified testing and inspecting agency**] to perform field tests and inspections and prepare test reports.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

C. Inspections:

1. Steel-reinforcement placement.
2. Steel-reinforcement mechanical splice couplers.
3. Steel-reinforcement welding.

D. Manufacturer's Inspections: Engage manufacturer of structural thermal break insulated connection system to inspect completed installations prior to placement of concrete, and to provide written report that installation complies with manufacturer's written instructions.

END OF SECTION 03 20 00

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete standards.
2. Concrete materials.
3. Vapor retarders.
4. Repair materials.
5. Concrete mixture materials.
6. Concrete mixture class types.
7. Concrete mixing.

B. Related Requirements:

1. Section 033300 "Architectural Concrete" for general building applications of specially finished formed concrete.
2. Section 312000 "Earth Moving" for drainage fill under slabs-on-ground.
3. Section 321313 "Concrete Paving" for concrete pavement and walks.

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement or blended hydraulic cement alone or in combination with one or more of the following:

1. Fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. Water/Cementitious Materials (w/cm) Ratio: The ratio by weight of mixing water to cementitious materials.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review the following:

a. Special inspection and testing and inspecting agency procedures for field quality control.
b. Construction joints, control joints, isolation joints, and joint-filler strips.
c. Semirigid joint fillers.
d. Vapor-retarder installation.
e. Anchor rod and anchorage device installation tolerances.
f. Cold- and hot-weather concreting procedures.

g. Concrete finishes and finishing.
h. Curing procedures.
i. Forms and form-removal limitations.
j. Steel reinforcement installation.
k. Methods for achieving specified floor and slab flatness and levelness.
l. Floor and slab flatness and levelness measurements.
m. Concrete repair procedures.
n. Concrete protection.
o. Initial curing of standard-cured and field curing of field-cured test cylinders (ASTM C31/C31M.)
p. Protection of field cured field test cylinders.
q. Distribution of test reports.

1.4 ACTION SUBMITTALS

A. Product Data for each type of project:

B. Design Mixtures: For each concrete mixture, include the following:

1. Mixture identification.
2. Compressive strength at 28 days or other age as specified.
3. Compressive strength required at stages of construction.
4. Durability exposure classes for Exposure Categories F, S, W, and C.
5. Maximum w/cm ratio.
6. Calculated equilibrium and fresh density for lightweight concrete.
7. Slump or slump flow limit.
8. Air content.
9. Nominal maximum aggregate size.
10. Submit adjustments to design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant changes.

C. Shop Drawings:

1. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

a. Location of construction joints is subject to approval of the Architect.

D. Concrete Schedule: For each location of each class of concrete indicated in "Concrete Mixture Class Types" Article, including the following:

1. Concrete class designation.
2. Location within Project.
3. Exposure class designation.
4. Formed surface finish designation and final finish.
5. Final finish for floors.
6. Floor treatment, if any.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: Installer

B. Material Certificates: For each of the following:

1. Cementitious materials.
2. Admixtures.
3. Fiber reinforcement.
4. Curing compounds.
5. Floor and slab treatments.
6. Bonding agents.
7. Adhesives.
8. Vapor retarders.
9. Semirigid joint filler.
10. Joint-filler strips.
11. Repair materials.

C. Material Test Reports: For the following:

1. Aggregates.

D. Floor surface flatness and levelness measurements report, indicating compliance with specified tolerances in accordance with ACI 117 and in compliance with ASTM E1155.

E. Field quality-control reports.

F. Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified Installer who employs Project personnel qualified as an ACI-certified Concrete Flatwork Associate and Concrete Flatwork Finisher and a supervisor who is a certified ACI Advanced Concrete Flatwork Finisher/Technician.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with ASTM C94/C94M and ACI 301.

1.8 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 301 as follows:

1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
2. When air temperature has fallen to, or is expected to fall below 40 deg F during the protection period, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.

3. Do not use frozen materials or materials containing ice or snow.
4. Do not place concrete in contact with surfaces less than 35 deg F, other than reinforcing steel.

B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1, and as follows:

1. Maintain concrete temperature at time of discharge to not exceed 90 deg F.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement sheet vapor retarder/termite barrier material and accessories for sheet vapor retarder/ termite barrier and accessories that do not comply with requirements or that fail to resist penetration by termites within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONCRETE STANDARDS

A. ACI Publications: Comply with ACI 301 unless modified by requirements in the Contract Documents.

2.2 CONCRETE MATERIALS

A. Indigenous Materials: Concrete shall be manufactured within **500 miles** of Project site from aggregates[**and cementitious materials**] that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles** of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

B. Source Limitations:

1. Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.
2. Obtain each type of admixture from single source from single manufacturer.

C. Cementitious Materials:

1. Portland Cement: ASTM C150/C150M, Type I, Type II.
2. Blended Hydraulic Cement: ASTM C595/C595M, Type IL, portland-limestone cement.
3. Pozzolans: ASTM C618, Class C or F.

D. Normal-Weight Aggregates:

1. Coarse Aggregate: ASTM C33/C33M, Class 3M.
2. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
3. Fine Aggregate: ASTM C33/C33M.

2.3 ADMIXTURES

A. Air-Entraining Admixture: ASTM C260/C260M.

B. Chemical Admixtures: Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.

C. Water: ASTM C 94 and potable.

2.4 VAPOR RETARDERS

A. Sheet Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10 mils (0.25mm) thick. Include manufacturer's recommended thickness and adhesive or pressure-sensitive tape.

2.5 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

B. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.

C. Water: Potable water that does not cause staining of the surface.

2.6 ACCESSORIES

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber or ASTM D1752, cork or self-expanding cork.

B. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

C. Epoxy Bonding Adhesive: ASTM C881/C881M, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade and class to suit requirements, and as follows:

1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.7 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand, as recommended by underlayment manufacturer.
4. Compressive Strength: Not less than 4100 psi at 28 days when tested in accordance with ASTM C109/C109M.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.

1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than 5000 psi at 28 days when tested in accordance with ASTM C109/C109M.

2.8 CONCRETE MIXTURE MATERIALS

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301.

1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland or hydraulic cement in concrete assigned to Exposure Class F3 as follows:

1. Fly Ash or Other Pozzolans: 20 percent by mass.

C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.

1. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
2. Use permeability-reducing admixture in concrete mixtures where indicated.

2.9 CONCRETE MIXTURE CLASS TYPES

A. Class A: Normal-weight concrete used for footings, grade beams, and tie beams.

1. Exposure Class: ACI 318 Class F2, Class S0, Class W1, Class C1.
2. Minimum Compressive Strength: As indicated
3. Maximum w/cm Ratio: 0.45
4. Slump Limit: 8 for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
5. Air Content:

    a. Exposure Classes F2 and F3: 6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size.

6. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 percent by weight of cementitious materials.

B. Class C: Normal-weight concrete used for interior slabs-on-ground.

1. Exposure Class: ACI 318 Class F0, Class S0, Class W0, Class C0.
2. Minimum Compressive Strength: 5000 psi, 4500 psi, 4000 psi, 3500 psi, 3000 psi, As indicated.
3. Maximum w/cm Ratio : 42
4. Slump Limit: 8 for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
5. Air Content:

    a. Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.

6. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 percent by weight of cement.

2.10 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M and furnish delivery ticket.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. Before placing concrete, verify that installation of concrete forms, accessories, reinforcement, and embedded items is complete and that required inspections have been performed.
2. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:

1. Daily access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.
4. Security and protection for test samples and for testing and inspection equipment at Project site.

3.3 TOLERANCES

A. Comply with ACI 117.

3.4 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install reglets to receive waterproofing and through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

3.5 INSTALLATION OF VAPOR RETARDERS

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.

1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
2. Face laps away from exposed direction of concrete pour.

3. Lap joints 6 inches and seal with manufacturer's recommended tape.

B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder in accordance with manufacturer's written instructions.

3.6 INSTALLATION OF CAST-IN-PLACE CONCRETE

A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.

1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.

B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.

C. Water addition in transit or at the Project site must be in accordance with ASTM C94/C94M and must not exceed the permitted amount indicated on the concrete delivery ticket.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.

1. If a section cannot be placed continuously, provide construction joints as indicated.
2. Deposit concrete to avoid segregation.
3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
4. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301.

    a. Do not use vibrators to transport concrete inside forms.
    b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.
    c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
    d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Do not place concrete floors and slabs in a checkerboard sequence.
2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3. Maintain reinforcement in position on chairs during concrete placement.

4. Screed slab surfaces with a straightedge and strike off to correct elevations.
5. Level concrete, cut high areas, and fill low areas.
6. Slope surfaces uniformly to drains where required.
7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
8. Do not further disturb slab surfaces before starting finishing operations.

3.7 INSTALLATION OF JOINTS

A. Construct joints true to line, with faces perpendicular to surface plane of concrete.

B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.

1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
2. Place joints perpendicular to main reinforcement.

    a. Continue reinforcement across construction joints unless otherwise indicated.

3. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
4. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.

D. Isolation Joints in Slabs-on-Ground: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated on Drawings.
2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface, where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints:

1. Install dowel bars and support assemblies at joints where indicated on Drawings.
2. Lubricate or asphalt coat one-half of dowel bar length to prevent concrete bonding to one side of joint.

3.8 APPLICATION OF FINISHING FLOORS AND SLABS

A. Scratch Finish:

1. While still plastic, texture concrete surface that has been screeded and bull-floated or darbied.
2. Use stiff brushes, brooms, or rakes to produce a profile depth of 1/4 inch in one direction.
3. Apply scratch finish to surfaces to receive concrete floor toppings, to receive mortar setting beds for bonded cementitious floor finishes.

B. Float Finish:

1. When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.
2. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture and complies with ACI 117 tolerances for conventional concrete.
3. Apply float finish to surfaces to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.

C. Trowel Finish:

1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
2. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance.
3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
4. Do not add water to concrete surface. Use of an approved finishing aid is acceptable.
5. Do not apply troweled finish to concrete, which has a total air content greater than 3 percent.
6. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
7. Finish surfaces to the following tolerances, in accordance with ASTM E1155, for a randomly trafficked floor surface:

    a. Slabs on Ground:

1) Specified overall values of flatness, FF 45; and of levelness, FL 35; with minimum local values of flatness, FF 30; and of levelness, FL 24.

D. Trowel and Fine-Broom Finish: First apply a trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thinset method. While concrete is still plastic, slightly scarify surface with a fine broom perpendicular to main traffic route.

1. Coordinate required final finish with Architect before application.
2. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

E. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with a fiber-bristle broom perpendicular to main traffic route.
2. Coordinate required final finish with Architect before application.

3.9 APPLICATION OF FINISHING FORMED SURFACES

A. As-Cast Surface Finishes:

1. ACI 301 (ACI 301M) Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.

a. Patch voids larger than 1-1/2 inches wide or 1/2 inch deep.
b. Remove projections larger than 1 inch.
c. Tie holes do not require patching.
d. Surface Tolerance: ACI 117, Class D.
e. Apply to concrete surfaces for metal lap pan deck formed surfaces and those surfaces that are buried or covered with subsequent installed surfaces.

B. Rubbed Finish: Apply the following to as-cast surface finishes where indicated on Drawings:

1. Smooth-Rubbed Finish:

a. Perform no later than one day after form removal.
b. Moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture.
c. If sufficient cement paste cannot be drawn from the concrete by the rubbing process, use a grout made from the same cementitious materials used in the in-place concrete.
d. Maintain required patterns or variances as shown on Drawings.

2. Grout-Cleaned Rubbed Finish:

a. Clean concrete surfaces after contiguous surfaces are completed and accessible.

b. Do not clean concrete surfaces as Work progresses.
c. Mix 1 part portland cement to 1-1/2 parts fine sand, complying with ASTM C144 or ASTM C404, by volume, with sufficient water to produce a mixture with the consistency of thick paint. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces.
d. Wet concrete surfaces.
e. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap, and keep surface damp by fog spray for at least 36 hours.

3.10 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

A. Filling in:

1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
2. Mix, place, and cure concrete, as specified, to match color and texture with in-place construction exposed to view.
3. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct concrete bases 4 inches high unless otherwise indicated on Drawings, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
3. Minimum Compressive Strength: 4000 psi at 28 days.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
6. Prior to pouring concrete, place and secure anchorage devices.

    a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
    b. Cast anchor-bolt insert into bases.
    c. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items.

1. Cast-in inserts and accessories, as shown on Drawings.
2. Screed, tamp, and trowel finish concrete surfaces.

3.11 APPLICATION OF CONCRETE CURING

A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

1. Comply with ACI 301 for cold weather protection during curing.
2. Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.

B. Curing Formed Surfaces: Comply with ACI 308.1 as follows:

1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
3. If forms remain during curing period, moist cure after loosening forms.
4. If removing forms before end of curing period, continue curing for remainder of curing period as follows:

    a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
    b. Continuous Sprinkling: Maintain concrete surface continuously wet.
    c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
    d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
    e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.

        1) Recoat areas subject to heavy rainfall within three hours after initial application.
        2) Maintain continuity of coating and repair damage during curing period.

C. Curing Unformed Surfaces: Comply with ACI 308.1 as follows:

1. Begin curing after finishing concrete.
2. Interior Concrete Floors:

    a. Absorbative Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.

        1) Lap edges and ends of absorptive cover not less than 12 inches.
        2) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

b. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.

1) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
2) Cure for not less than seven days.

c. Floors To Receive Curing Compound:

1) Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
2) Recoat areas subjected to heavy rainfall within three hours after initial application.
3) Maintain continuity of coating, and repair damage during curing period.
4) Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.

d. Floors To Receive Curing and Sealing Compound:

1) Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller in accordance with manufacturer's written instructions.
2) Recoat areas subjected to heavy rainfall within three hours after initial application.
3) Repeat process 24 hours later, and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

3.2 INSTALLATION OF JOINT FILLING

A. Prepare, clean, and install joint filler in accordance with manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least one month.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints.

D. Overfill joint, and trim joint filler flush with top of joint after hardening.

3.3 INSTALLATION OF CONCRETE SURFACE REPAIRS

A. Defective Concrete:

1. Repair and patch defective areas when approved by Architect.
2. Remove and replace concrete that cannot be repaired and patched to meet specification requirements.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks in excess of 0.01 inch spalls, air bubbles exceeding surface finish limits, honeycombs, rock pockets, fins and other projections on the surface exceeding surface finish limits, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete.

    a. Limit cut depth to 3/4 inch.
    b. Make edges of cuts perpendicular to concrete surface.
    c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
    d. Fill and compact with patching mortar before bonding agent has dried.
    e. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement, so that, when dry, patching mortar matches surrounding color.

    a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
    b. Compact mortar in place and match surrounding surface.

3. Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance, as determined by Architect.

D. Repairing Unformed Surfaces:

1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.

    a. Correct low and high areas.
    b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width.
3. After concrete has cured at least 14 days, correct high areas by grinding.
4. Correct localized low areas during, or immediately after, completing surface-finishing operations by adding patching mortar.

a. Finish repaired areas to blend into adjacent concrete.

5. Correct other low areas scheduled to receive floor coverings with a repair underlayment.

   a. Prepare, mix, and apply repair underlayment and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
   b. Feather edges to match adjacent floor elevations.

6. Correct other low areas scheduled to remain exposed with repair topping.

   a. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations.
   b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

7. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete.

   a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a 3/4-inch clearance all around.
   b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
   c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
   d. Place, compact, and finish to blend with adjacent finished concrete.
   e. Cure in same manner as adjacent concrete.

8. Repair random cracks and single holes 1 inch or less in diameter with patching mortar.

   a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
   b. Dampen cleaned concrete surfaces and apply bonding agent.
   c. Place patching mortar before bonding agent has dried.
   d. Compact patching mortar and finish to match adjacent concrete.
   e. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

1. Testing agency to be responsible for providing curing facility for initial curing of strength test specimens on-site and verifying that test specimens are cured in accordance with standard curing requirements in ASTM C31/C31M.
2. Testing agency to immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
3. Testing agency to report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.

    a. Test reports to include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301, including the following as applicable to each test and inspection:

        1) Project name.
        2) Name of testing agency.
        3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
        4) Name of concrete manufacturer.
        5) Date and time of inspection, sampling, and field testing.
        6) Date and time of concrete placement.
        7) Location in Work of concrete represented by samples.
        8) Date and time sample was obtained.
        9) Truck and batch ticket numbers.
        10) Design compressive strength at 28 days.
        11) Concrete mixture designation, proportions, and materials.
        12) Field test results of fresh concrete, including slump or slump flow, air content, temperature and density.
        13) Information on storage and curing of samples at the Project site, including curing method and maximum and minimum temperatures during initial curing period.
        14) Type of fracture and compressive break strengths at seven days and 28 days.

4. Provide a space and source of power or other resources for curing and access to test specimens by the testing agency.

C. Delivery Tickets: comply with ASTM C94/C94M.

D. Inspections:

1. Headed bolts and studs.
2. Verification of use of required design mixture.
3. Concrete placement, including conveying and depositing.
4. Curing procedures and maintenance of curing temperature.
5. Verification of concrete strength before removal of shores and forms from beams and slabs.
6. Batch Plant Inspections: On a random basis, as determined by Architect.

E. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M to be performed in accordance with the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 150 cu. yd. or fraction thereof.

    a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing is to be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C143/C143M:

    a. One test at point of delivery for each composite sample, but not less than one test for each day's pour of each concrete mixture.
    b. Perform additional tests as needed.

3. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete.

    a. One test for each composite sample when strength test specimens are cast, but not less than one test for each day's pour of each concrete mixture.

4. Concrete Temperature: ASTM C1064/C1064M:

    a. One test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample when strength test specimens are cast.

5. Compression Test Specimens: ASTM C31/C31M:

    a. Cast, and field cure two sets of two standard cylindrical specimens for each composite sample.

6. Compressive-Strength Tests: ASTM C39/C39M.

    a.
    b. Test one set of two field-cured specimens at seven days and one set of two specimens at 28 days.
    c. A compressive-strength test to be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

7. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests of standard cured cylinders equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than 500 psi if specified compressive strength is 5000 psi, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi.

8. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
9. Additional Tests:

    a. Testing and inspecting agency to make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
    b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.

        1) Acceptance criteria for concrete strength to be in accordance with ACI 301, Section 1.7.6.3.

10. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
11. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

F. Measure floor and slab flatness and levelness in accordance with ASTM E1155 within 24 hours of completion of floor finishing and promptly report test results to Architect.

3.5 PROTECTION

A. Protect concrete surfaces as follows:

1. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION 033000

SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Structural steel.
2. Prefabricated building columns.
3. Grout.

B. Related Requirements:

1. Section 053100 "Steel Decking" for field installation of shear connectors through deck.
2. Section 055000 "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame, miscellaneous steel fabrications and other steel items not defined as structural steel.
3. Section 133419 "Metal Building Systems" for structural steel.

1.3 DEFINITIONS

A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

1.4 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment Drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.

C. Delegated-Design Submittal: For structural-steel connections indicated to comply with design loads, include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, fabricator and testing agency.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Mill test reports for structural steel, including chemical and physical properties.

E. Product Test Reports: For the following:

1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
2. Direct-tension indicators.
3. Tension-control, high-strength, bolt-nut-washer assemblies.
4. Shear stud connectors.
5. Shop primers.
6. Nonshrink grout.

F. Survey of existing conditions.

G. Source quality-control reports.

H. Field quality-control and special inspection reports.

1.8 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.

B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.

C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P1, Endorsement P2, Endorsement P3 or to SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."

D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8/D1.8M. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.

E. Comply with applicable provisions of the following specifications and documents:

1. AISC 303.
2. AISC 360.
3. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
2. Clean and relubricate bolts and nuts that become dry or rusty before use.
3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand loads indicated and comply with other information and restrictions indicated.

1. Select and complete connections using AISC 360.
2. Use Load and Resistance Factor Design; data are given at factored-load level.

B. Moment Connections: Type FR, fully restrained.

2.2 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A 992/A 992M, ASTM A 572/A 572M, Grade 50 (345).

B. Channels, Angles: ASTM A 36/A 36M.

C. Plate and Bar: ASTM A 36/A 36M.

D. Corrosion-Resisting Structural-Steel Shapes, Plates, and Bars: ASTM A 588/A 588M, Grade 50 (345).

E. Cold-Formed Hollow Structural Sections: ASTM A 500/A 500M, Grade C, structural tubing.

F. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, (ASTM A 563M, Class 8S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers; all with plain finish.

1. Direct-Tension Indicators: ASTM F 959, Type 325 (ASTM F 959M, Type 8.8), compressible-washer type with plain finish.

B. High-Strength Bolts, Nuts, and Washers: ASTM A 490 (ASTM A 490M), Type 1, heavy-hex steel structural bolts or tension-control, bolt-nut-washer assemblies with splined ends; ASTM A 563, Grade DH, (ASTM A 563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers with plain finish.

1. Direct-Tension Indicators: ASTM F 959, Type 490 (ASTM F 959M, Type 10.9), compressible-washer type with plain finish.

C. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH (ASTM A 563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers.

1. Finish: Hot-dip or mechanically deposited zinc coating.
2. Direct-Tension Indicators: ASTM F 959, Type 325 (ASTM F 959M, Type 8.8), compressible-washer type with mechanically deposited zinc coating finish.

D. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

E. Unheaded Anchor Rods**:** ASTM F 1554, Grade 36.

1. Configuration: Straight.
2. Nuts: ASTM A 563 (ASTM A 563M) heavy**-**hex carbon steel.
3. Plate Washers: ASTM A 36/A 36M carbon steel.
4. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
5. Finish: Plain, Hot-dip zinc coating, ASTM A 153/A 153M, Class C.

F. Threaded Rods: ASTM A 36/A 36M.

1. Nuts: ASTM A 563 (ASTM A 563M) heavy**-**hex carbon steel.
2. Washers: ASTM A 36/A 36M carbon steel.
3. Finish: Plain, Hot-dip zinc coating, ASTM A 153/A 153M, Class C.

2.4 PRIMER

A. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

B. Galvanizing Repair Paint: ASTM A 780/A 780M.

2.5 GROUT

A. Metallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.

B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.6 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," and to AISC 360.

1. Camber structural-steel members where indicated.
2. Fabricate beams with rolling camber up.
3. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
4. Mark and match-mark materials for field assembly.

5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 2, "Hand Tool Cleaning."

F. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

G. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural-steel frame. Straighten as required to provide uniform, square, and true members in completed wall framing. Build up welded framing, weld exposed joints continuously, and grind smooth.

H. Welded Door Frames: Build up welded door frames attached to structural-steel frame. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk machine screws, uniformly spaced not more than 10 inches (250 mm) o.c. unless otherwise indicated.

I. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.

1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.7 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

2.8 PREFABRICATED BUILDING COLUMNS

A. Prefabricated building columns consisting of load-bearing structural-steel members protected by concrete fireproofing encased in an outer non-load-bearing steel shell.

B. Fire-Resistance Ratings: Provide prefabricated building column listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for ratings indicated, based on testing according to ASTM E 119.

1. Fire-Resistance Rating: As indicated.

2.9 SHOP PRIMING

A. Shop prime steel surfaces except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
2. Surfaces to be field welded.
3. Surfaces of high-strength bolted, slip-critical connections.
4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
5. Galvanized surfaces.
6. Surfaces enclosed in interior construction.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:

1. SSPC-SP 2, "Hand Tool Cleaning."
2. SSPC-SP 3, "Power Tool Cleaning."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

2.10 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.

1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.

2. Galvanize lintels, shelf angles, and welded door frames attached to structural-steel frame and located in exterior walls.

2.11 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform shop tests and inspections.

1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. Bolted Connections: Inspect shop-bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Welded Connections: Visually inspect shop-welded connections according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

1. Liquid Penetrant Inspection: ASTM E 165.
2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
3. Ultrasonic Inspection: ASTM E 164.
4. Radiographic Inspection: ASTM E 94.

D. In addition to visual inspection, test and inspect shop-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:

1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.

2. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

B. Baseplates Bearing Plates and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate.
3. Pretension anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.

G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

H. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.

2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," for mill material.

3.5 PREFABRICATED BUILDING COLUMNS

A. Install prefabricated building columns to comply with AISC 360, manufacturer's written recommendations, and requirements of testing and inspecting agency that apply to the fire-resistance rating indicated.

3.6 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:

1. Verify structural-steel materials and inspect steel frame joint details.
2. Verify weld materials and inspect welds.
3. Verify connection materials and inspect high-strength bolted connections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Bolted Connections: Inspect and test bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. Welded Connections: Visually inspect field welds according to AWS D1.1/D1.1M.

1. In addition to visual inspection, test and inspect field welds according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

a. Liquid Penetrant Inspection: ASTM E 165.

b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
c. Ultrasonic Inspection: ASTM E 164.
d. Radiographic Inspection: ASTM E 94.

E. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:

1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.

2. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

3.7 REPAIRS AND PROTECTION

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780/A 780M.

B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

C. Touchup Painting: Cleaning and touchup painting are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

D. Touchup Priming: Cleaning and touchup priming are specified in Section 099600 "High-Performance Coatings."

END OF SECTION 051200

SECTION 05 21 00 - STEEL JOIST FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel joists and joist girders.
2. Primers.
3. Steel joist accessories.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for installing bearing plates in concrete.
2. Section 042000 "Unit Masonry" for installing bearing plates in unit masonry.
3. Section 051200 "Structural Steel Framing" for field-welded shear connectors.

1.2 DEFINITIONS

A. SJI's "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."

B. Special Joists: Steel joists or joist girders requiring modification by manufacturer to support nonuniform, unequal, or special loading conditions that invalidate load tables in SJI's "Specifications."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include layout, designation, number, type, location, and spacing of joists.
2. Include joining and anchorage details; bracing, bridging, and joist accessories; splice and connection locations and details; and attachments to other construction.
3. Indicate locations and details of bearing plates to be embedded in other construction.

C. Delegated Design Submittals: For steel joist framing, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. <**Insert additional requirements if needed**>.

D. Sustainable Design Submittals:

1. Environmental Product Declaration (EPD): For each product.
2. Environmental Product Declaration (EPD): For each product.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

C. Mill Certificates: For each type of bolt.

D. Comprehensive engineering analysis of special joists signed and sealed by the qualified professional engineer responsible for its preparation.

E. Field quality control reports.

F. Qualification Statements: For [**manufacturer**][**Erector**][**testing agency**].

G. Delegated Design Engineer Qualifications: For steel joist framing.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables in SJI's "Specifications[**."**][**" and "Standard Specification for Composite Steel Joists, CJ-Series" in "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice."**]

1. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.

B. Erector Qualifications: An experienced Erector who specializes in erecting and installing work similar in material, design, and extent to that indicated for this Project and who is acceptable to manufacturer.

C. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in [**state**]<**Insert jurisdiction**> where Project is located and who is experienced in providing engineering services of the type indicated.

D. Welding Qualifications: Qualify field-welding procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle joists as recommended in SJI's "Specifications[**."**][**" and "Standard Specification for Composite Steel Joists, CJ-Series" in "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice."**]

B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

1.7 SEQUENCING

A. Deliver steel bearing plates to be built into [**cast-in-place concrete**][**and**][**masonry**] construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design steel joist framing.

B. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated on Drawings.

1. Use [**ASD; data are given at service-load level**][**LRFD; data are given at factored-load level**].
2. Design special joists to withstand design loads with live-load deflections no greater than the following:

a. Floor Joists: Vertical deflection of [**1/360**][**1/240**] of the span.
b. Roof Joists: Vertical deflection of [**1/360**][**1/240**] of the span.

C. <**Insert requirements**>.

D. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

2.2 STEEL JOISTS AND JOIST GIRDERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Canam Buildings US Inc.; Canam Group Inc.**]
2. [**Gooder-Henrichsen Co.**]
3. [**New Millennium Building Systems, LLC**]
4. [**Valley Joist**]
5. [**Vulcraft/Verco Group; a division of Nucor Corp.**]
6. <**Insert manufacturer's name**>

B. K-Series Steel Joist: Manufactured steel joists of type indicated in accordance with "Standard Specification for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top

chord.

1. Joist Type: [**K-series steel joists**][**and**][**KCS-type K-series steel joists**].
2. K-Series Steel Joist Substitutes: Manufactured in accordance with "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle or -channel members.
3. Provide holes in chord members for connecting and securing other construction to joists.
4. Top-Chord Extensions: Extend top chords of joists with SJI's Type S top-chord extensions where indicated on Drawings, complying with SJI's "Specifications."
5. Extended Ends: Extend bearing ends of joists with SJI's Type R extended ends as indicated on Drawings, complying with SJI's "Specifications."
6. Do not camber joists.
7. Camber joists [**in accordance with SJI's "Specifications."**][**as indicated on Drawings.**]<**Insert camber requirements**>.
8. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches.

C. Long-Span Steel Joist: Manufactured in accordance with "Standard Specification for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members; of joist type and end and top-chord arrangements[**as follows:**][**as indicated on Drawings.**]

1. Joist Type: [**LH-series long-span steel joists**][**and**][**DLH-series long-span steel joists**].
2. End Arrangement: [**Underslung**][**Square**].
3. Top-Chord Arrangement: [**Parallel**][**Pitched 1/8 inch per 12 inches, one way**][**Pitched 1/8 inch per 12 inches, two ways**]<**Insert pitch**>.
4. Provide holes in chord members for connecting and securing other construction to joists.
5. Camber long-span steel joists [**in accordance with SJI's "Specifications."**][**as indicated on Drawings.**]<**Insert camber requirements**>.
6. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches.

D. Composite Steel Joist: Manufactured in accordance with "Standard Specifications for Composite Steel Joists, CJ-Series" in SJI's "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice," with steel-angle top- and bottom-chord members and parallel top chord, and with [**underslung**][**square**] ends.

1. Camber composite steel joists [**as indicated on Drawings**]<**Insert camber requirements**>.

E. Joist Girders: Manufactured in accordance with "Standard Specification for Joist Girders" in SJI's "Specifications," with steel-angle top- and bottom-chord members; with end and top-chord arrangements[**as follows:**][**as indicated on Drawings.**]

1. End Arrangement: [**Underslung**][**Underslung with bottom-chord extensions**][**Square**].
2. Top-Chord Arrangement: [**Parallel**][**Pitched 1/8 inch per 12 inches, one**

way][**Pitched 1/8 inch per 12 inches, two ways**]<**Insert pitch**>.

3. Provide holes in chord members for connecting and securing other construction to joist girders.
4. Camber joist girders [**in accordance with SJI's "Specifications."**][**as indicated on Drawings.**]<**Insert camber requirements**>.
5. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches.

2.3 PRIMERS

A. Primer:

1. SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.
2. Provide shop primer that complies with [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**]

2.4 STEEL JOIST ACCESSORIES

A. Bridging:

1. Provide bridging anchors and number of rows of [**horizontal**][**or**][**diagonal**] bridging of material, size, and type required by SJI's "Specifications"[**and "Standard Specification for Composite Steel Joists, CJ-Series" in "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice"**] for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.
2. Detail and fabricate in accordance with SJI's "Specifications[**."**][**" and "Standard Specification for Composite Steel Joists, CJ-Series" in "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice."**] Furnish additional erection bridging if required for stability.
3. Fabricate as indicated on Drawings and in accordance with SJI's "Specifications[**."**][**" and "Standard Specification for Composite Steel Joists, CJ-Series" in "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice."**] Furnish additional erection bridging if required for stability.

B. Fabricate steel bearing plates from ASTM A36/A36M steel with integral anchorages of sizes and thicknesses indicated on Drawings. [**Shop prime paint**][**Hot-dip zinc coat in accordance with ASTM A123/A123M**].

C. Steel bearing plates with integral anchorages are specified in Section 055000 "Metal Fabrications."

D. Furnish ceiling extensions, either extended bottom-chord elements or a separate extension unit of enough strength to support ceiling construction.

1. Extend ends to within 1/2 inch of finished wall surface unless otherwise indicated on Drawings.
2. Finish: [**Plain, uncoated**][**Hot-dip zinc coating, ASTM A153/A153M, Class C**][**Mechanically deposited zinc coating, ASTM B695, Class 50**].

E. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563/A563M, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

1. Finish: [**Plain**][**Hot-dip zinc coating, ASTM A153/A153M, Class C**][**Mechanically deposited zinc coating, ASTM B695, Class 50**].

F. Welding Electrodes: Comply with AWS standards.

G. Galvanizing Repair Paint: [**MPI#18, MPI#19, or SSPC-Paint 20**][**ASTM A780/A780M**].

H. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly.

2.5 CLEANING AND SHOP PAINTING

A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by [**hand-tool cleaning, SSPC-SP 2**][**or**][**power-tool cleaning, SSPC-SP 3**].

B. Do not prime paint joists and accessories[**to receive sprayed fire-resistive materials**].

C. Apply one coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1 mil thick.

D. Shop priming of joists and joist accessories is specified in [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**]

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates, embedded bearing plates, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF STEEL JOISTS AND JOIST GIRDERS

A. Do not install joists until supporting construction is in place and secured.

B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction in accordance with SJI's "Specifications[**,"**][**" and "Standard Specification for Composite Steel Joists, CJ-Series" in "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice,"**] joist manufacturer's written instructions, and requirements in this Section.

1. Before installation, splice joists delivered to Project site in more than one piece.
2. Space, adjust, and align joists accurately in location before permanently fastening.
3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
4. Delay rigidly connecting bottom-chord extensions to columns or supports until dead loads are applied.

C. Field weld joists to supporting steel [**bearing plates**][**and**][**framework**]. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

D. Bolt joists to supporting steel framework using carbon-steel bolts.

E. Bolt joists to supporting steel framework using high-strength structural bolts. Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for high-strength structural bolt installation and tightening requirements.

F. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

3.3 REPAIRS

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint in accordance with ASTM A780/A780M and manufacturer's written instructions.

B. Touchup Painting:

1. Immediately after installation, clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists[**, bearing plates,**][**abutting structural steel,**] and accessories.

   a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
   b. Apply a compatible primer of same type as primer used on adjacent surfaces.

2. Cleaning and touchup painting are specified in [**Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**][**Section 099600 "High-Performance Coatings."**]

3.4 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**][**Engage**] a qualified testing agency to perform tests and inspections.

B. Visually inspect field welds in accordance with AWS D1.1/D1.1M.

C. Visually inspect bolted connections.

D. Prepare test and inspection reports.

END OF SECTION 05 21 00

SECTION 053100 - STEEL DECKING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof deck.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill over steel deck.
2. Section 051200 "Structural Steel Framing" for shop- and field-welded shear connectors.
3. Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Roof deck.

B. Shop Drawings:

1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of steel deck.

B. Test and Evaluation Reports:

1. Product Test Reports: For tests performed by a qualified testing agency, indicating that each of the following complies with requirements:

a. Power-actuated mechanical fasteners.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with SDI QA/QC and the following welding codes:

1. AWS D1.1/D1.1M.
2. AWS D1.3/D1.3M.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Store products in accordance with SDI MOC3. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck in accordance with AISI S100.

B. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from listings of another qualified testing agency.

2.2 ROOF DECK

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ASC Steel Deck; ASC Profiles, LLC
2. Canam Buildings US Inc.; Canam Group Inc.
3. CSM Metal Deck
4. New Millennium Building Systems, LLC
5. OEG Building Materials Inc
6. Vulcraft/Verco Group; a division of Nucor Corp.

B. Fabrication of Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with SDI RD and with the following:

1. Prime-Painted Steel Sheet: ASTM A1008/A1008M, Structural Steel (SS), Grade 33 minimum, shop primed with manufacturer's standard baked-on, rust-inhibitive primer.

a. Color: Manufacturer's standard.

2. Deck Profile: As indicated.
3. Profile Depth: As indicated.
4. Design Uncoated-Steel Thickness: As indicated.
5. Span Condition: As indicated.
6. Side Laps: As indicated.

2.3 ACCESSORIES

A. Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.

G. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0598 inch thick, with factory-punched hole of 3/8-inch minimum diameter.

H. Galvanizing Repair Paint: ASTM A780.

I. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install deck panels and accessories in accordance with SDI C, SDI NC, and SDI RD, as applicable; manufacturer's written instructions; and requirements in this Section.

B. Install temporary shoring before placing deck panels if required to meet deflection limitations.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install in accordance with deck manufacturer's written instructions.

3.3 INSTALLATION OF ROOF DECK

A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches long, and as follows:

1. Weld Diameter: 5/8 inch, nominal.
2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds as indicated.
3. Weld Washers: Install weld washers at each weld location.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or at intervals indicated and as follows:

1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
2. Mechanically clinch or button punch.
3. Fasten with a minimum of 1-1/2-inch-long welds.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:

1. End Joints: Lapped 2 inches minimum.

D. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end

closures, and reinforcing channels in accordance with deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.

1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.

E. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive in accordance with manufacturer's written instructions to ensure complete closure.

3.4 REPAIR

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint in accordance with ASTM A780/A780M and manufacturer's written instructions.

B. Repair Painting:

1. Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation and apply repair paint.
2. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.
3. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
4. Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Special inspections and qualification of welding special inspectors for cold-formed steel floor and roof deck in accordance with quality-assurance inspection requirements of SDI QA/QC.

    a. Field welds will be subject to inspection.

2. Steel decking will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 053100

SECTION 05 51 13 - METAL PAN STAIRS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preassembled steel stairs with concrete-filled treads.
2. Steel tuberailings and guards attached to metal stairs.
3. Steel tubehandrails attached to walls adjacent to metal stairs.

1.2 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for metal stairs, railings, and guards.

1. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, blocking for attachment of wall-mounted handrails, and items with integral anchors, that are to be embedded in concrete or masonry.
2. Deliver such items to Project site in time for installation.

C. Coordinate locations of hanger rods and struts with other work so they do not encroach on required stair width and are within fire-resistance-rated stair enclosure.

D. Schedule installation of railings and guards so wall attachments are made only to completed walls.

1. Do not support railings and guards temporarily by any means that do not satisfy structural performance requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For metal pan stairs and the following:

1. Perforated metal.
2. Woven-wire mesh.
3. Welded-wire mesh.
4. Prefilled metal-pan-stair treads.
5. Abrasive nosings.
6. Shop primer products.
7. Nonslip-aggregate concrete finish.
8. Abrasive-coating finish to formed-metal stairs.

9. Handrail wall brackets.
10. Grout.

B. Shop Drawings:

1. Include plans, elevations, sections, details, and attachments to other work.
2. Indicate sizes of metal sections, thickness of metals, profiles, holes, and field joints.
3. Include plan at each level.
4. Indicate locations of anchors, weld plates, and blocking for attachment of wall-mounted handrails.

C. Samples for Verification: For each type and finish of nosing.

D. Delegated Design Submittal: For stairs, railings and guards,, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that engineer is licensed in the State in which Project is located.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification.

1. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers.
2. Protect steel members and packaged materials from corrosion and deterioration.
3. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures.

a. Repair or replace damaged materials or structures as directed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design stairs, railings and guards,, including attachment to building construction.

B. Structural Performance of Stairs: Metal stairs withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load: 100 lbf/sq. ft..
2. Concentrated Load: 300 lbf applied on an area of 4 sq. in..
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing and guard loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to L/360 or 1/4 inch, whichever is less.

C. Structural Performance of Railings and Guards: Railings and guards, including attachment to building construction, withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:

    a. Uniform load of 50 lbf/ft. applied in any direction.
    b. Concentrated load of 200 lbf applied in any direction.
    c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

    a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft..
    b. Infill load and other loads need not be assumed to act concurrently.

3. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

    a. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

D. Seismic Performance of Stairs: As indicated on drawings.

2.2 METALS

A. Metal Surfaces: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

C. Steel Tubing for Railings and Guards: ASTM A500/A500M (cold formed).

D. Steel Pipe for Railings and Guards: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

E. Uncoated, Cold-Rolled Steel Sheet: ASTM A1008/A1008M, structural steel, Grade 25, unless another grade is required by design loads; exposed.

F. Uncoated, Hot-Rolled Steel Sheet: ASTM A1011/A1011M, structural steel, Grade 30, unless another grade is required by design loads.

G. Galvanized Steel Sheet: ASTM A653/A653M, G90 coating, structural steel, Grade 33, unless another grade is required by design loads.

H. Expanded-Metal, Carbon Steel: ASTM F1267, , Class 1 (uncoated).

I. Perforated Metal, Uncoated: Cold-rolled steel sheet, ASTM A1008/A1008M, or hot-rolled steel sheet, ASTM A1011/A1011M, commercial steel Type B, 0.060 inch thick, with 1/4-inch holes 3/8 inch o.c. in staggered rows.

J. Perforated Metal, Galvanized Steel Sheet: ASTM A653/A653M, G90 coating, commercial steel Type B, 0.064 inch thick, with 1/4-inch holes 3/8 inch o.c. in staggered rows.

K. Welded-Wire Mesh: Diamond pattern, 2-inch welded-wire mesh, made from 0.236-inch nominal-diameter steel wire complying with ASTM A510/A510M.

L. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

2.3 ABRASIVE NOSINGS

A. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.

B. Apply bituminous paint to concealed surfaces of cast-metal units set into concrete.

C. Apply clear lacquer to concealed surfaces of extruded units set into concrete.

D. Extruded Units: As indicated on Drawings.

2.4 FASTENERS

A. General: Provide zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5 where built into exterior walls.

1. Select fasteners for type, grade, and class required.

B. Fasteners for Anchoring Railings and Guards to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring

railings and guards to other types of construction indicated and capable of withstanding design loads.

C. Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.

D. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.

2.5 MISCELLANEOUS MATERIALS

A. Welding Electrodes: Comply with AWS requirements.

B. Shop Primers: Provide primers that comply with Section 099600 "High-Performance Coatings."

C. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

D. Zinc-Rich Primer: Comply with SSPC-Paint 20, and compatible with topcoat.

E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish system indicated.

F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with ASTM A780/A780M and compatible with paints specified to be used over it.

G. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout; recommended by manufacturer for interior use; noncorrosive and nonstaining; mixed with water to consistency suitable for application and a 30-minute working time.

H. Prefilled Concrete Treads:

1. Concrete Materials and Properties: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with minimum 28-day compressive strength of 3000 psi and maximum aggregate size of 1/2 inch unless otherwise indicated.
2. Nonslip-Aggregate Concrete Finish: Factory-packaged abrasive aggregate made from fused, aluminum-oxide grits or crushed emery; rustproof and nonglazing;

unaffected by freezing, moisture, or cleaning materials.

3. Plain Steel Welded-Wire Reinforcement: ASTM A1064/A10645M, steel, 6 by 6 inches, W1.4 by W1.4, unless otherwise indicated on Drawings.
4. Reinforcement Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening welded-wire reinforcement in place.

    a. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete.

2.6 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, struts, railings and guards, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

1. Join components by welding unless otherwise indicated.
2. Use connections that maintain structural value of joined pieces.

B. Assemble stairs, railings, and guards in shop to greatest extent possible.

1. Disassemble units only as necessary for shipping and handling limitations.
2. Clearly mark units for reassembly and coordinated installation.

C. Cut, drill, and punch metals cleanly and accurately.

1. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated.
2. Remove sharp or rough areas on exposed surfaces.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Form exposed work with accurate angles and surfaces and straight edges.

F. Weld connections to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Weld exposed corners and seams continuously unless otherwise indicated.
5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #1 - No evidence of welded joint.

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.

1. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated.

2. Locate joints where least conspicuous.
3. Fabricate joints that will be exposed to weather in a manner to exclude water.
4. Provide weep holes where water may accumulate internally.

2.7 FABRICATION OF STEEL-FRAMED STAIRS

A. NAAMM Stair Standard: Comply with NAAMM AMP 510, "Metal Stairs Manual," for Architectural Class, unless more stringent requirements are indicated.

B. Stair Framing:

1. Stringers: Fabricate of steel rectangular tubes.

    a. Stringer Size: As required to comply with "Performance Requirements" Article.
    b. Provide closures for exposed ends of channel and rectangular tube stringers.
    c. Finish: Shop primed.

2. Platforms: Construct of steel rectangular tube headers and miscellaneous framing members as required to comply with "Performance Requirements" Article.

    a. Provide closures for exposed ends of channel and rectangular tube framing.
    b. Finish: Shop primed.

3. Weld or bolt stringers to headers; weld or bolt framing members to stringers and headers. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.
4. Where stairs are enclosed by gypsum board assemblies, provide hanger rods or struts to support landings from floor construction above or below.

    a. Locate hanger rods and struts where they do not encroach on required stair width and are within the fire-resistance-rated stair enclosure.

5. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.

C. Metal Pan Stairs: Form risers, subtread pans, and subplatforms to configurations shown from steel sheet of thickness needed to comply with performance requirements, but not less than 0.067 inch.

1. Steel Sheet, Uncoated: Cold-rolled steel sheet unless otherwise indicated.
2. Directly weld metal pans to stringers; locate welds on top of subtreads where they will be concealed by concrete fill. Do not weld risers to stringers.
3. Attach risers and subtreads to stringers with brackets made of steel angles or bars. Weld brackets to stringers and attach metal pans to brackets by welding, riveting, or bolting.
4. Shape metal pans to include nosing integral with riser.

5. Attach abrasive nosings to risers.
6. At Contractor's option, provide stair assemblies with metal pan subtreads filled with reinforced concrete during fabrication.
7. Provide subplatforms of configuration indicated or, if not indicated, the same as subtreads. Weld subplatforms to platform framing.

    a. Smooth Soffit Construction: Construct subplatforms with flat metal under surfaces to produce smooth soffits.

D. Abrasive-Coating-Finished, Formed-Metal Stairs: Form risers, treads, and platforms to configurations shown from steel sheet of thickness needed to comply with performance requirements, but not less than 0.097 inch.

1. Steel Sheet: Uncoated, hot-rolled steel sheet unless otherwise indicated.
2. Directly weld risers and treads to stringers; locate welds on underside of stairs.
3. Provide platforms of configuration indicated or, if not indicated, the same as treads. Weld platforms to platform framing.
4. Finish tread and platform surfaces with manufacturer's standard epoxy-bonded abrasive finish.

2.8 FABRICATION OF STAIR RAILINGS AND GUARDS

A. Fabricate railings and guards to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of member, post spacings, wall bracket spacing, and anchorage, but not less than that needed to withstand indicated loads.

B. Welded Connections: Fabricate railings and guards with welded connections.

1. Fabricate connections that are exposed to weather in a manner that excludes water.

    a. Provide weep holes where water may accumulate internally.

2. Cope components at connections to provide close fit, or use fittings designed for this purpose.
3. Weld all around at connections, including at fittings.
4. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
5. Obtain fusion without undercut or overlap.
6. Remove flux immediately.
7. Finish welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #1 - No evidence of a welded joint as shown in NAAMM AMP 521.

C. Form changes in direction of railings and guards as follows:

1. As detailed.

D. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout

entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

E. Close exposed ends of railing and guard members with prefabricated end fittings.

F. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated.

G. Connect posts to stair framing by direct welding unless otherwise indicated.

H. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work.

1. Furnish inserts and other anchorage devices for connecting to concrete or masonry work.
2. For galvanized railings and guards, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous-metal components.
3. For nongalvanized railings and guards, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors embedded in exterior masonry and concrete construction.
4. Provide type of bracket with flange tapped for concealed anchorage to threaded hanger bolt and that provides 1-1/2-inch clearance from inside face of handrail to finished wall surface.

I. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports.

1. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.

2.9 FINISHES

A. Finish metal stairs after assembly.

B. Preparation for Shop Priming: Prepare uncoated, ferrous-metal surfaces to comply with SSPC-SP 3, "Power Tool Cleaning."

C. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify elevations of floors, bearing surfaces and locations of bearing plates, and other embedments for compliance with requirements.

1. For wall-mounted railings, verify locations of concealed reinforcement within gypsum board and plaster assemblies.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF METAL PAN STAIRS

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction.

1. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.

1. Grouted Baseplates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates.

a. Clean bottom surface of plates.
b. Set plates for structural members on wedges, shims, or setting nuts.
c. Tighten anchor bolts after supported members have been positioned and plumbed.
d. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
e. Promptly pack grout solidly between bearing surfaces and plates so no voids remain.

1) Neatly finish exposed surfaces; protect grout and allow to cure.
2) Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

E. Fit exposed connections accurately together to form hairline joints.

1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
2. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
3. Comply with requirements for welding in "Fabrication, General" Article.

F. Place and finish concrete fill for treads and platforms to comply with Section 033000 "Cast-in-Place Concrete."

1. Install abrasive nosings with anchors fully embedded in concrete.
2. Center nosings on tread width.

3.3 INSTALLATION OF RAILINGS AND GUARDS

A. Adjust railing and guard systems before anchoring to ensure matching alignment at abutting joints with tight, hairline joints.

1. Space posts at spacing indicated or, if not indicated, as required by design loads.
2. Plumb posts in each direction, within a tolerance of 1/16 inch in 3 feet.
3. Align rails and guards so variations from level for horizontal members and variations from parallel with rake of stairs for sloping members do not exceed 1/4 inch in 12 feet.
4. Secure posts, rail ends, and guard ends to building construction as follows:

    a. Anchor posts to steel by welding to steel supporting members.
    b. Anchor handrail and guard ends to concrete and masonry with steel round flanges welded to rail and guard ends and anchored with post-installed anchors and bolts.

B. Install railing gates level, plumb, and secure for full opening without interference.

1. Attach hardware using tamper-resistant or concealed means.
2. Adjust hardware for smooth operation.

C. Attach handrails to wall with wall brackets.

1. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
2. Secure wall brackets to building construction as required to comply with performance requirements.

3.4 REPAIR

A. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

    a. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

END OF SECTION 05 51 13

SECTION 06 10 00 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wood products.
2. Wood-preservative-treated lumber.
3. Fire-retardant-treated lumber.
4. Miscellaneous lumber.
5. Plywood backing panels.

1.2 DEFINITIONS

A. Boards or Strips: Lumber of less than 2 inches nominal size in least dimension.

B. Dimension Lumber: Lumber of 2 inches nominal size or greater but less than 5 inches nominal size in least dimension.

C. Lumber grading agencies, and abbreviations used to reference them, include the following:

1. NeLMA: Northeastern Lumber Manufacturers' Association.
2. NLGA: National Lumber Grades Authority.
3. SPIB: The Southern Pine Inspection Bureau.
4. WCLIB: West Coast Lumber Inspection Bureau.
5. WWPA: Western Wood Products Association.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency in accordance with ASTM D5664.
4. For products receiving a waterborne treatment, include statement that moisture

content of treated materials was reduced to levels specified before shipment to Project site.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates:

1. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Stack wood products flat with spacers beneath and between each bundle to provide air circulation. Protect wood products from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS

A. Lumber: Comply with DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry wood products.

B. Maximum Moisture Content:

1. Boards: 15 percent.
2. Dimension Lumber: 15 percent unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

A. Preservative Treatment by Pressure Process: AWPA U1, Use categories as follows:

1. UC1: Interior construction not in contact with ground or subject to moisture. Include all rough carpentry.

a. Wood sills, sleepers, blocking, furring,and similar concealed members in contact with masonry or concrete.
b. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
c. Wood furniture.

d. Wood millwork.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat all rough carpentry unless otherwise indicated.

2.3 FIRE-RETARDANT-TREATED LUMBER

A. General: Where fire-retardant-treated materials are indicated, materials are to comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested in accordance with ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.

1. Treatment is not to promote corrosion of metal fasteners.
2. Interior Type A: Treated materials are to have a moisture content of 28 percent or less when tested in accordance with ASTM D3201/D3201M at 92 percent relative humidity. Use where exterior type is not indicated.
3. Design Value Adjustment Factors: Treated lumber is to be tested according to ASTM D5664 and design value adjustment factors are to be calculated according to ASTM D6841.

C. Kiln-dry lumber after treatment to maximum moisture content of 19 percent. Kiln-dry plywood after treatment to maximum moisture content of 15 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency and other information required by authorities having jurisdiction.

E. Application: Treat all rough carpentry unless otherwise indicated.

2.4 MISCELLANEOUS LUMBER

A. Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Furring.

B. Concealed Boards: 15 percent maximum moisture content and any ofthe following species and grades:

1. Mixed southern pine or southern pine; No. 2 grade; SPIB.
2. Hem-fir or hem-fir (north); Construction or No. 2 Common grade; NLGA, WCLIB, or WWPA.
3. Spruce-pine-fir (south) or spruce-pine-fir; Construction or No. 2 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
4. Eastern softwoods; No. 2 Common grade; NeLMA.
5. Northern species; No. [**2**][**3**] Common grade; NLGA.
6. Western woods; Construction or No. 2 Common grade; WCLIB or WWPA.

C. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

D. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.5 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: Plywood, DOC PS 1, Exterior, C-C Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

2.6 FASTENERS

A. General: Fasteners are to be of size and type indicated and comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than 1-1/2 inches into wood substrate.

1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M or ASTM F2329.

B. Nails, Brads, and Staples: ASTM F1667.

C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 ICC-ES AC58 ICC-ES AC193 or ICC-ES AC308 as appropriate for the substrate.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.

B. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.

C. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.

D. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.

E. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

F. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

1. Use inorganic boron for items that are continuously protected from liquid water.
2. Use copper naphthenate for items not continuously protected from liquid water.

G. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. Table 2304.10.1, "Fastening Schedule," in ICC's International Building Code (IBC).

H. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 INSTALLATION OF WOOD BLOCKING AND NAILERS

A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach wood blocking to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

3.3 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered

borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06 10 00

SECTION 06 16 00 - SHEATHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wall sheathing.
2. Sheathing joint-and-penetration treatment materials.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for plywood backing panels.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review air-barrier and water-resistant glass-mat gypsum sheathing requirements and installation, special details, transitions, air-leakage testing, protection, and work scheduling that covers air-barrier and water-resistant glass-mat gypsum sheathing.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Wall sheathing.
2. Sheathing joint-and-penetration treatment materials.

B. Product Data Submittals: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. For products receiving waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications:

1. For testing agency providing classification marking for fire-retardant-treated

material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance Ratings: As tested in accordance with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 WALL SHEATHING

A. Glass-Mat Gypsum Sheathing, Walls: ASTM C1177/C1177M.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. CertainTeed; SAINT-GOBAIN
    b. Georgia-Pacific Gypsum LLC
    c. USG Corporation

2. Type and Thickness: Type X, 5/8 inch thick.
3. Size: 48 by 96 inches for vertical installation.

B. Air-Barrier and Water-Resistant Glass-Mat Gypsum Sheathing: ASTM C1177/C1177M, Type X, coated fiberglass mat gypsum sheathing with integral weather-resistant barrier and air barrier complying with ASTM E2178.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Georgia-Pacific Gypsum LLC
    b. USG Corporation

2. Thickness: 5/8 inch thick.

3. Size: 48 by 96 inches for vertical installation.
4. Edges: Square.
5. Flashing and Transitions Strips: As acceptable to sheathing manufacturer.
6. Air Permeance: Maximum 0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. pressure difference when tested in accordance with ASTM E2178.
7. Vapor Permeance: Minimum 20 perms when tested in accordance with ASTM E96/E96M, Desiccant Method, Procedure A.
8. Sheathing Assembly Air Leakage: Maximum 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft. when tested in accordance with ASTM E2357.
9. Fire Propagation Characteristics: Complies with NFPA 285 testing as part of an approved assembly.
10. UV Resistance: Can be exposed to sunlight for 30 days in accordance with manufacturer's written instructions.
11. Provide primers, transition strips, termination strips, joint reinforcing fabric and strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by sheathing manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.

C. Cementitious Backer Units, Walls: ASTM C1325, Type A.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Custom Building Products
    b. FinPan, Inc.
    c. USG Corporation

2. Thickness: 5/8 inch.

2.3 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. For wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.
2. For wall sheathing, provide fasteners with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours in accordance with ASTM B117.

B. Nails, Brads, and Staples: ASTM F1667.

C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Screws for Fastening Sheathing to Wood Framing: ASTM C1002.

E. Screws for Fastening Wood Structural Panels to Cold-Formed Metal Framing: ASTM C954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.

F. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached.

1. For steel framing less than 0.0329 inch thick, use screws that comply with ASTM C1002.
2. For steel framing from 0.033 to 0.112 inch thick, use screws that comply with ASTM C954.

G. Screws for Fastening Composite Nail Base Insulated Roof Sheathing to Metal Roof Deck: Steel drill screws, in type and length recommended by sheathing manufacturer for thickness of sheathing to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours in accordance with ASTM B117. Provide washers or plates if recommended by sheathing manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:

1. Table 2304.10.1, "Fastening Schedule," in the ICC's International Building Code.
2. ICC-ES evaluation report for fastener.

D. Coordinate wall sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

F. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 INSTALLATION OF GYPSUM SHEATHING

A. Comply with GA-253 and with manufacturer's written instructions.

1. Fasten gypsum sheathing to wood framing with screws.
2. Fasten gypsum sheathing to cold-formed metal framing with screws.
3. Install panels with a 3/8-inch gap where non-load-bearing construction abuts structural elements.
4. Install panels with a 1/4-inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.

B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.

C. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent panels without forcing. Abut ends over centers of studs, and stagger end joints of adjacent panels not less than one stud spacing. Attach at perimeter and within field of panel to each stud.

1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of panels.

D. Vertical Installation: Install vertical edges centered over studs. Abut ends and edges with those of adjacent panels. Attach at perimeter and within field of panel to each stud.

1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of panels.

E. Seal sheathing joints in accordance with sheathing manufacturer's written instructions.

1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient amount of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.
2. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and trowel sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.

F. Air-Barrier and Water-Resistant Glass-Mat Gypsum Sheathing:

1. Install accessory materials in accordance with sheathing manufacturer's written instructions and details to form a seal with adjacent construction, to seal fasteners, and ensure continuity of air and water barrier.

a. Coordinate the installation of sheathing with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
b. Install transition strip on roofing membrane or base flashing, so that a minimum of 3 inches of coverage is achieved over each substrate.

2. Connect and seal sheathing material continuously to air barriers specified under other Sections as well as to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
3. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
4. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, doors, and miscellaneous penetrations of sheathing material with foam sealant.
5. Seal top of through-wall flashings to sheathing with an additional 6-inch- wide, transition strip.
6. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.
7. Repair punctures, voids, and deficient lapped seams in strips and transition strips extending 6 inches beyond repaired areas in strip direction.

3.3 INSTALLATION OF CEMENTITIOUS BACKER UNITS

A. Install panels and treat joints in accordance with ANSI A108.11 and manufacturer's written instructions for type of application indicated.

3.4 FIELD QUALITY CONTROL

A. Testing and Inspecting Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests: As determined by testing agency from among the following tests:

C. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

D. Prepare test and inspection reports.

END OF SECTION 06 16 00

SECTION 07 21 00 - THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glass-fiber blanket insulation.

B. Related Requirements:

1. Section 092900 "Gypsum Board" for sound attenuation blanket used as acoustic insulation.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Installer's Certification: Listing type, manufacturer, and R-value of insulation installed in each element of the building thermal envelope.

B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

C. Research Reports: For foam-plastic insulation, from ICC-ES.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect foam-plastic board insulation as follows:

1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Maximum flame-spread and smoke-developed indexes less than Class A, 25 and 450 when tested in accordance with ASTM E84.

B. Fire-Resistance Ratings: Comply with ASTM E119 or UL 263; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from listings of another qualified testing agency.

C. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.

D. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

E. Thermal-Resistance Value (R-Value): R-value as indicated on Drawings in accordance with ASTM C518.

2.2 GLASS-FIBER BLANKET INSULATION

A. Glass-Fiber Blanket Insulation, Polypropylene-Scrim-Kraft Faced: ASTM C665, Type II (nonreflective faced), Class A (faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier).

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. CertainTeed; SAINT-GOBAIN
b. Johns Manville; a Berkshire Hathaway company
c. Owens Corning

2.3 INSULATION FASTENERS

A. Insulation Fastener Accessories: Provide double-pointed weld pins, lagging pins, quilting pins, duct liner pins, insulation hangers, specialty washers, special caps, j-hooks, capacitor discharge annular weld pins, capacitor discharge acoustical lagging pins, and other accessory materials that are recommended in writing by insulation fastener manufacturer to produce complete insulation supports.

2.4 ACCESSORIES

A. Insulation for Miscellaneous Voids:

1. Glass-Fiber Insulation: ASTM C764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E84.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or those that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products, applications and applicable codes.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.3 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

A. Blanket Insulation: Install in cavities formed by framing members in accordance with the following requirements:

1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
4. Attics: Install eave ventilation troughs between roof framing members in insulated attic spaces at vented eaves.
5. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
6. Vapor-Retarder-Faced Blankets: Tape joints and ruptures in vapor-retarder facings, and seal each continuous area of insulation to ensure airtight installation.

    a. Exterior Walls: Set units with facing placed toward interior of construction.

b. Interior Walls: Set units with facing placed toward areas of high humidity.

B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:

1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft..

3.4 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.

B. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 07 21 00

SECTION 07 27 15 - NONBITUMINOUS SELF-ADHERING SHEET AIR BARRIERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Self-adhering air barrier.

1. Vapor-permeable nonbituminous sheet.

B. Related Requirements:

1. Section 061600 "Sheathing" for wall sheathings and wall sheathing joint-and-penetration treatments.

1.2 DEFINITIONS

A. Air-Barrier Accessory: A transitional component of the air barrier that provides continuity.

B. Air-Barrier Assembly: The collection of air-barrier materials and accessories applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

C. Air-Barrier Material: A primary element that provides a continuous barrier to the movement of air.

1.3 ACTION SUBMITTALS

A. Product Data: Self-adhering air barrier. Include manufacturer's written instructions for evaluating, preparing, and treating each substrate; technical data; and tested physical and performance properties of products.

1. Vapor-permeable nonbituminous sheet.

B. Shop Drawings: For air-barrier assemblies.

1. Show locations and extent of air-barrier materials, accessories, and assemblies specific to Project conditions.
2. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
3. Include details of interfaces with other materials that form part of air barrier.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer. Include list of ABAA-certified installers and supervisors employed by Installer, who work on Project.

B. Product Certificates: From air-barrier manufacturer, certifying compatibility of air barriers and accessory materials with Project materials that connect to or that come in contact with air barrier.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1. Installer to be licensed by ABAA in accordance with ABAA's Quality Assurance Program and to employ ABAA-certified installers and supervisors on Project.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Remove and replace liquid materials that cannot be applied within their stated shelf life.

B. Protect stored materials from direct sunlight.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended in writing by air-barrier manufacturer.

1. Protect substrates from environmental conditions that affect air-barrier performance.
2. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain primary air-barrier materials and air-barrier accessories from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Air-Barrier Performance: Air-barrier assembly and seals with adjacent construction to be capable of performing as a continuous air barrier. Air-barrier assemblies to be

capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, tie-ins to installed waterproofing, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

B. Air-Barrier Assembly Air Leakage: Maximum 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft., when tested in accordance with ASTM E2357.

2.3 NONBITUMINOUS SHEET AIR BARRIER

A. Vapor-Permeable Nonbituminous Sheet: Minimum 20-mil- thick, self-adhering sheet consisting of a breathable carrier film or fabric and an adhesive with release liner on adhesive side.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Carlisle Coatings & Waterproofing Inc
    b. GCP Applied Technologies Inc.
    c. W. R. Meadows, Inc

2. Physical and Performance Properties:

    a. Air Permeance: Maximum 0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. pressure difference; ASTM E2178.
    b. Puncture Resistance: Minimum 40 lbf; ASTM E154/E154M.
    c. Vapor Permeance: Minimum 15 perms; ASTM E96/E96M, Desiccant Method, Procedure A.
    d. Adhesion to Substrate: Minimum 16 lbf/sq. in. when tested in accordance with ASTM D4541 as modified by ABAA.
    e. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
    f. UV Resistance: Can be exposed to sunlight for 50 days in accordance with manufacturer's written instructions.

2.4 ACCESSORY MATERIALS

A. Requirement: Provide primers, transition strips, termination strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by air-barrier manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.

B. Primer: Liquid waterborne primer recommended for substrate by air-barrier material manufacturer.

C. Stainless Steel Sheet: ASTM A240/A240M, Type 304, 0.0187 inch thick, and Series

300 stainless steel fasteners.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
2. Verify that substrates have cured and aged for minimum time recommended in writing by air-barrier manufacturer.
3. Verify that substrates are visibly dry and free of moisture. Test concrete substrates for capillary moisture by plastic sheet method in accordance with ASTM D4263.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

A. Clean, prepare, treat, fill, and seal substrate and joints and cracks in substrate in accordance with manufacturer's written instructions and details. Provide clean, dust-free, and dry substrate for air-barrier application.

B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.

C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching membrane.

E. Remove excess mortar from masonry ties, shelf angles, and other obstructions.

F. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.

G. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.

H. Bridge isolation joints expansion joints and discontinuous wall-to-wall, deck-to-wall, and deck-to-deck joints with air-barrier accessory material that accommodates joint movement in accordance with manufacturer's written instructions and details.

3.3 INSTALLATION OF NONBITUMINOUS SHEET AIR BARRIER

A. Install materials in accordance with air-barrier manufacturer's written instructions and details to form a seal with adjacent construction and ensure continuity of air and water barrier.

1. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow it to dry.

B. Prepare, treat, and seal inside and outside corners and vertical and horizontal surfaces at terminations and penetrations with termination mastic.

C. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by air-barrier sheet on same day. Reprime areas exposed for more than 24 hours.

D. Apply and firmly adhere air-barrier sheets over area to receive air barrier. Accurately align sheets and maintain uniform 2-1/2-inch- minimum lap widths and end laps. Overlap and seal seams, and stagger end laps to ensure airtight installation.

1. Apply sheets in a shingled manner to shed water.
2. Roll sheets firmly to enhance adhesion to substrate.

E. Apply continuous air-barrier sheets over accessory strips bridging substrate cracks, construction, and contraction joints.

F. Seal exposed edges of sheet at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.

G. Install air-barrier sheet and accessory materials to form a seal with adjacent construction and to maintain a continuous air barrier.

1. Coordinate air-barrier installation with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
2. Install transition strip on roofing membrane or base flashing so that a minimum of 3 inches of coverage is achieved over each substrate.

H. Connect and seal exterior wall air-barrier sheet continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.

I. At end of each working day, seal top edge of air-barrier material to substrate with termination mastic.

J. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

K. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls,

storefronts, and doors. Apply transition strip so that a minimum of 3 inches of coverage is achieved over each substrate. Maintain 3 inches of contact over firm bearing to perimeter frames, with not less than 1 inch of full contact.

1. Transition Strip: Roll firmly to enhance adhesion.

L. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, doors, and miscellaneous penetrations of air-barrier material with foam sealant.

M. Repair punctures, voids, and deficient lapped seams in air barrier. Slit and flatten fishmouths and blisters. Patch with air-barrier sheet extending 6 inches beyond repaired areas in all directions.

N. Do not cover air barrier until it has been tested and inspected by testing agency.

O. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.4 FIELD QUALITY CONTROL

A. ABAA Quality Assurance Program: Perform examinations, preparation, installation, testing, and inspections under ABAA's Quality Assurance Program.

B. Inspections: Air-barrier materials, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:

1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
2. Continuous structural support of air-barrier system has been provided.
3. Masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions, and mortar droppings.
4. Site conditions for application temperature and dryness of substrates have been maintained.
5. Maximum exposure time of materials to UV deterioration has not been exceeded.
6. Surfaces have been primed.
7. Laps in sheet materials have complied with the minimum requirements and have been shingled in the correct direction (or mastic applied on exposed edges), with no fishmouths.
8. Termination mastic has been applied on cut edges.
9. Air barrier has been firmly adhered to substrate.
10. Compatible materials have been used.
11. Transitions at changes in direction and structural support at gaps have been provided.
12. Connections between assemblies (air barrier and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
13. All penetrations have been sealed.

C. Air barriers will be considered defective if they do not pass tests and inspections.

1. Apply additional air-barrier material, in accordance with manufacturer's written instructions, where inspection results indicate insufficient thickness.
2. Remove and replace deficient air-barrier components for retesting as specified above.

D. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

E. Prepare test and inspection reports.

3.5 CLEANING AND PROTECTION

A. Protect air-barrier system from damage during application and remainder of construction period, in accordance with manufacturer's written instructions.

1. Protect air barrier from exposure to UV light and harmful weather exposure as recommended in writing by manufacturer. If exposed to these conditions for longer than recommended, remove and replace air barrier or install additional, full-thickness, air-barrier application after repairing and preparing the overexposed materials in accordance with air-barrier manufacturer's written instructions.
2. Protect air barrier from contact with incompatible materials and sealants not approved by air-barrier manufacturer.

B. Clean spills, stains, and soiling from construction that would be exposed in the completed Work, using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION 07 27 15

SECTION 07 42 13.19 - INSULATED METAL WALL PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Foamed-insulation-core metal wall panels.

B. Related Requirements:

1. Section 074293 "Soffit Panels" for metal panels used in horizontal soffit applications.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of doors, windows, and louvers.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that affect metal panels.
6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
7. Review temporary protection requirements for metal panel assembly during and after installation.
8. Review procedures for repair of metal panels damaged after installation.
9. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Foamed-insulation-core metal wall panels.
2. Laminated-insulation-core metal wall panels.

B. Product Data Submittals: For each product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

C. Shop Drawings:

1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.

D. Samples for Initial Selection: For each type of metal panel indicated with factory-applied color finishes.

1. Include similar Samples of trim and accessories involving color selection.

E. Samples for Verification: For each type of exposed finish, prepared on Samples of size indicated below.

1. Metal Panels: 12 inches long by actual panel width. Include fasteners, closures, and other metal panel accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each product, tests performed by a qualified testing agency.

C. Field quality-control reports.

D. Sample Warranties: For special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panels to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal panels during installation.

1.8 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed in accordance with manufacturers' written instructions and warranty requirements.

1.9 COORDINATION

A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

    a. Structural failures including rupturing, cracking, or puncturing.
    b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

    a. Color fading more than 5 Hunter units when tested in accordance with ASTM D2244.
    b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
    c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing in accordance with ASTM E72:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: As indicated on Drawings.
3. Deflection Limits: For wind loads, no greater than 1/180 of the span.

B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested in accordance with ASTM E283 at the following test-pressure difference:

1. Test-Pressure Difference: 1.57 lbf/sq. ft..

C. Water Penetration under Static Pressure: No water penetration when tested in accordance with ASTM E331 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft..

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

E. Fire-Test-Response Characteristics: Provide metal wall panels and system components with the following fire-test-response characteristics, as determined by testing identical panels and system components per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.

1. Fire-Resistance Characteristics: Provide materials and construction tested for fire resistance per ASTM E119.
2. Radiant Heat Exposure: No ignition when tested in accordance with NFPA 268.
3. Potential Heat: Acceptable level when tested in accordance with NFPA 259.
4. Surface-Burning Characteristics: Provide wall panels with a flame-spread index of 25 or less and a smoke-developed index of 450 or less, per ASTM E84.

2.2 FOAMED-INSULATION-CORE METAL WALL PANELS

A. General: Provide factory-formed and -assembled metal wall panels fabricated from two metal facing sheets and insulation core foamed in place during fabrication, and with joints between panels designed to form weathertight seals. Include accessories required for weathertight installation.

1. Insulation Core: Modified isocyanurate or polyurethane foam using a non-CFC blowing agent, with maximum flame-spread and smoke-developed indexes of 25 and 450, respectively.

    a. Closed-Cell Content: 90 percent when tested in accordance with ASTM D6226.
    b. Density: 2.0 to 2.6 lb/cu. ft. when tested in accordance with ASTM D1622.
    c. Compressive Strength: Minimum 20 psi when tested in accordance with ASTM D1621.
    d. Shear Strength: 26 psi when tested in accordance with ASTM C273/C273M.

B. Exposed-Fastener, Foamed-Insulation-Core Metal Wall Panels: Formed with a raised, trapezoidal major rib at panel edge and two intermediate stiffening ribs symmetrically spaced between major rib and panel edge; designed for lapping side edges of adjacent panels and mechanically attaching to supports using exposed fasteners in side laps.

1. Metallic-Coated Steel Sheet: Facings of zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Nominal Thickness: 0.022 inch.
    b. Exterior Finish: Two-coat fluoropolymer.

        1) Color: As selected by Architect from manufacturer's full range.

    c. Interior Finish: Siliconized polyester.

        1) Color: As selected by Architect from manufacturer's full range.

2. Backer Board: On back side of exterior facing.
3. Snap-on Batten: Same material, finish, and color as exterior facings of wall panels.
4. Panel Coverage: 40 inches nominal.
5. Panel Thickness: 2.5 inches.
6. Thermal-Resistance Value (R-Value): 18.0 in accordance with ASTM C1363.

C. Concealed-Fastener, Foamed-Insulation-Core Metal Wall Panels: Formed with tongue-and-groove panel edges; designed for sequential installation by interlocking panel edges and mechanically attaching panels to supports using concealed clips or fasteners.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. All Weather Insulated Panels

2. Metallic-Coated Steel Sheet: Facings of zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, G90 coating designation, or aluminum-zinc

alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

a. Nominal Thickness: 0.022 inch.
b. Exterior Finish: Two-coat fluoropolymer.

1) Color: As selected by Architect from manufacturer's full range.

c. Interior Finish: Siliconized polyester.

1) Color: As selected by Architect from manufacturer's full range.

3. Snap-on Batten: Same material, finish, and color as exterior facings of wall panels.
4. Panel Coverage: 40 inches nominal.
5. Panel Thickness: 2.5 inches.
6. Thermal-Resistance Value (R-Value): 18.0 in accordance with ASTM C1363.

D. General: Provide factory-formed and -assembled metal wall panels fabricated from two metal facing sheets and core material laminated or otherwise securely bonded to facing sheets during fabrication without use of contact adhesives, and with joints between panels designed to form weathertight seals. Include accessories required for weathertight installation.

2.3 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C645, cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 coating designation or ASTM A792/A792M, Class AZ50 aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls,

framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

E. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
2. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.4 FABRICATION

A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

C. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.5 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Steel Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. FEVE Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
3. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil for primer and 0.8 mil for topcoat.
4. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.

1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.

a. Verify that air- or water-resistive barriers have been installed over

sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages in accordance with ASTM C754 and metal panel manufacturer's written recommendations.

3.3 INSTALLATION OF METAL PANELS

A. General: Install metal panels in accordance with manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal panels.
2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as metal panel work proceeds.
6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:

1. Steel Panels: Use stainless steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
2. Aluminum Panels: Use aluminum or stainless steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior.

C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where

required for weathertight performance of metal wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal wall panel manufacturer.

1. Seal metal wall panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal wall panel manufacturer.
2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

3.4 INSTALLATION OF INSULATION-CORE METAL WALL PANELS

A. General: Apply continuous ribbon of sealant to panel joint on concealed side of insulated metal wall panels as vapor seal; apply sealant to panel joint on exposed side of panels for weather seal.

1. Fasten foamed-insulation-core metal wall panels to supports with fasteners at each lapped joint at location and spacing and with fasteners recommended by manufacturer.
2. Apply panels and associated items true to line for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.
3. Provide metal-backed washers under heads of exposed fasteners on weather side of insulated metal wall panels.
4. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
5. Provide sealant tape at lapped joints of insulated metal wall panels and between panels and protruding equipment, vents, and accessories.
6. Apply a continuous ribbon of sealant tape to panel side laps and elsewhere as needed to make panels weathertight.
7. Apply snap-on battens to exposed-fastener, insulated-core metal wall panel seams to conceal fasteners.

B. Foamed-Insulation-Core Metal Wall Panels: Fasten metal wall panels to supports with concealed clips at each joint at location and spacing and with fasteners recommended by manufacturer. Fully engage tongue and groove of adjacent panels.

1. Install clips to supports with self-tapping fasteners.

C. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.

D. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level. Install work

with laps, joints, and seams that are permanently watertight.

1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to achieve waterproof performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

3.5 FIELD QUALITY CONTROL

A. Water-Spray Test: After installation, test area of assembly as directed by Architect for water penetration in accordance with AAMA 501.2.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed metal wall panel installation, including accessories.

C. Metal wall panels will be considered defective if they do not pass test and inspections.

D. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

E. Prepare test and inspection reports.

3.6 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 42 13.19

SECTION 07 42 93 - SOFFIT PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal soffit panels.

B. Related Requirements:

1. Section 074213.13 "Formed Metal Wall Panels" for lap-seam metal wall panels.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Metal soffit panels.

B. Product Data Submittals:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

C. Shop Drawings:

1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
2. Accessories: Include details of flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:

1. Metal Panels: 12 inches long by actual panel width. Include fasteners, closures, and other metal panel accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each product, tests performed by a qualified testing agency.

C. Sample Warranties: For special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panels to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal panels during installation.

1.8 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.9 COORDINATION

A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of walls, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including rupturing, cracking, or puncturing.
b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: As indicated on Drawings.
3. Deflection Limits: For wind loads, no greater than 1/240 of the span.

B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E283 at the following test-pressure difference:

1. Test-Pressure Difference: 1.57 lbf/sq. ft..

C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E331 at the following test-pressure difference:

1. Test-Pressure Difference: 2.86 lbf/sq. ft..

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of

components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.2 METAL SOFFIT PANELS

A. General - Refer to product indicated on Drawings.

B. Provide metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in side laps. Include accessories required for weathertight installation.

C. Metal Soffit Panels: Match profile and material of metal wall panels.

1. Finish: As indicated on Drawings.

D. Flush-Profile Metal Soffit Panels: Solid panels formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced between panel edges; with flush joint between panels.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Berridge Manufacturing Company
    b. CENTRIA, a Nucor Brand
    c. Dimensional Metals, Inc.
    d. PAC-CLAD; Petersen; a Carlisle company

2. Material - As indicated on Drawings.
3. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Nominal Thickness: 0.022 inch.
    b. Exterior Finish: Two-coat fluoropolymer.
    c. Color: As indicated on Drawings.

4. Panel Coverage: 12 inches.
5. Panel Height: 1.0 inch.

2.3 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C645, cold-formed, metallic-

coated steel sheet, ASTM A653/A653M, G90 hot-dip galvanized coating designation or ASTM A792/A792M, Class AZ50 aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Finish flashing and trim with same finish system as adjacent metal panels.

D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

E. Panel Sealants: Provide sealant types recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
2. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.4 FABRICATION

A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.

C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

    a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal soffit panel manufacturer for application but not less than thickness of metal being secured.

2.5 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Steel Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

D. Aluminum Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Exposed Anodized Finish:

a. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.

1. Examine framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal panel manufacturer.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

1. Soffit Framing: Wire tie or clip furring channels to supports, as required to comply with requirements for assemblies indicated.

3.3 INSTALLATION OF METAL SOFFIT PANELS

A. Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal panels.
2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as metal panel work proceeds.
6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
7. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:

1. Steel Panels: Use stainless steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
2. Aluminum Panels: Use aluminum or stainless steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior.
3. Copper Panels: Use copper, stainless steel, or hardware-bronze fasteners.
4. Stainless Steel Panels: Use stainless steel fasteners.

C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

D. Lap-Seam Metal Panels: Fasten metal panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.

1. Apply panels and associated items true to line for neat and weathertight enclosure.
2. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of metal panels.
3. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
4. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.

E. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel system including trim, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.

F. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.

1. Install exposed flashing and trim that is without buckling, and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to achieve waterproof performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant

(concealed within joints).

3.4 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 42 93

SECTION 07 54 23 - THERMOPLASTIC-POLYOLEFIN (TPO) ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermoplastic polyolefin (TPO) roofing system.
2. Accessory roofing system materials.
3. Vapor retarder.
4. Roof insulation and accessories.
5. Cover board.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking; and for wood-based, structural-use roof deck panels.
2. Section 061600 "Sheathing" for wood-based, structural-use roof deck panels.
3. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
4. Section 077100 "Roof Specialties" for roof edge flashings.
5. Section 077129 "Manufactured Roof Expansion Joints" for premanufactured roof expansion-joint assemblies.
6. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.

1.2 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D1079 and glossary in NRCA's " Roofing Manual: Membrane Roof Systems" apply to Work of this Section.

1.3 PREINSTALLATION MEETINGS

A. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, Roofing System Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

4. Review deck substrate requirements for conditions and finishes, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

B. Preinstallation Roofing Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, Roofing System Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include roof plans, sections, details, and attachments to other work, including the following:

1. Layout and thickness of insulation.
2. Base and sheet flashings and membrane termination details.
3. Flashing details at penetrations.
4. Tapered insulation layout, thickness, and slopes.
5. Roof plan showing orientation of roof deck and orientation of roofing membrane, fastening spacings, and pattern for corner, perimeter, and field-of-roof locations.
6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
7. Tie-in with adjoining wall system air barrier.

C. Wind-Uplift-Resistance Submittal: For roofing system indicating compliance with wind-uplift performance requirements.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer Certificates:

1. Performance Requirement Certificate: Signed by roofing membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

    a. Submit evidence of compliance with specified performance requirements.

2. Special Warranty Certificate: Signed by roofing membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

B. Product Test Reports: For roofing membrane and insulation, tests performed by an independent qualified testing agency indicating compliance with specified requirements.

C. Field Test Reports:

1. Concrete internal relative humidity test reports.
2. Fastener-pullout test results and manufacturer's revised requirements for fastener patterns.

D. Field quality-control reports.

E. Qualification Data: For roofing system Installer andmanufacturer.

F. Sample warranties.

G. Evaluation Reports: For components of roofing systems, from ICC-ES.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is UL listed orlisted in FM Approvals' RoofNav orlisted in SPRI's "Directory of Roof Assemblies" for roofing system identical to that used for this Project.

B. Installer Qualifications: A qualified firm that is approved, authorized, certified, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing system materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.

1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources.

1. Store in a dry location.
2. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing system materials, and place equipment in a manner to avoid permanent deflection of deck.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed in accordance with manufacturer's written installation instructions and warranty requirements.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

1. Special warranty to include all components of roofing system, such as substrate board, vapor retarder, roof insulation, fasteners, adhesives, cover board,roofing membrane, base flashing sheet, and other components of roofing system.
2. Warranty Period: 20 years from date of Substantial Completion.

B. Roofing System Installer's Warranty: Submit Roofing System Installer's warranty, on warranty form at end of this Section, signed by Roofing System Installer, covering the Work of this Section, including all components of roofing system, such as substrate board, vapor retarder, roof insulation, fasteners, adhesives, cover board,roofing membrane, base flashing sheet, and other components of roofing system.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Installed roofing system and flashings to withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing system and flashings to remain watertight.

1. Accelerated Weathering: Roofing membrane to withstand 2000 hours of exposure when tested in accordance with ASTM G152, ASTM G154, or ASTM G155.
2. Impact Resistance: Roofing membrane to resist impact damage when tested in accordance with ASTM D3746/D3746M, ASTM D4272/D4272M, or the Resistance to Foot Traffic Test in FM Approvals 4470.

B. Material Compatibility: Roofing system materials to be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roofing membrane manufacturer based on testing and field experience.

C. Wind-Uplift Resistance: Design roofing system to resist the following wind-uplift pressures when tested in accordance with FM Approvals 4474, UL 580, or UL 1897:

D. FM Approvals' RoofNav Listing: Roofing membrane, base flashings, and component materials to comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and are listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.

1. Fire/Windstorm Classification: Class 1A-120.
2. Hail-Resistance Rating: FM Global Property Loss Prevention Data Sheet 1-34 VSH.

E. Exterior Fire-Test Exposure: Class A; for application and roof slopes indicated; when tested by a qualified testing agency in accordance with ASTM E108 or UL 790.

1. Identify products with appropriate markings of applicable testing agency.

F. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated.

1. Identify products with appropriate markings of applicable testing agency.

2.2 THERMOPLASTIC POLYOLEFIN (TPO) ROOFING SYSTEM

A. TPO Roofing Membrane Sheet: ASTM D6878/D6878M, internally fabric- or scrim-reinforced, fabric-backed TPO sheet.

1. Manufacturers: Subject to compliance with requirements, available

manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Carlisle Syntec Systems
b. GAF
c. Johns Manville; a Berkshire Hathaway company

2. Thickness: 60 mil, nominal.
3. Exposed Face Color: Gray.
4. Source Limitations - Obtain components for roofing system from roof membrane manufacturer.

2.3 ACCESSORY ROOFING SYSTEM MATERIALS

A. General: Accessory materials as recommended in writing by roofing membrane manufacturer for intended use and compatible with other roofing system components.

1. Adhesive and Sealants: Comply with VOC limits of authorities having jurisdiction.

B. Base and Sheet Flashings: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and color as roofing membrane.

C. Prefabricated Pipe Flashings: As recommended in writing by roofing membrane manufacturer.

D. Roof Vents: As recommended in writing by roofing membrane manufacturer.

1. Size: Not less than 4-inch diameter.

E. Bonding Adhesive: Roofing membrane manufacturer's standard.

F. Slip Sheet: Manufacturer's standard, of thickness required for application.

G. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.

H. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick, prepunched.

I. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing system components to substrate; tested for required pullout strength, and acceptable to roofing membrane manufacturer.

J. Miscellaneous Accessories: As recommended in writing by roofing membrane manufacturer.

K. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M, cellulosic-fiber reinforced, water-resistant gypsum board.

1. Thickness: [**1/4 inch**][**3/8 inch**][**1/2 inch**][**5/8 inch**].

L. Perlite Board: ASTM C728, seal coated.

1. Thickness: [**3/4 inch**][**1 inch**].

M. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

N. Bonding Adhesive: Manufacturer's standard, designed for adhering substrate board to roof deck.

2.4 ROOF INSULATION AND ACCESSORIES

A. General: Preformed roof insulation boards manufactured or approved by roofing membrane manufacturer, approved for use in listed roof assemblies.

B. Extruded-Polystyrene Board Insulation: ASTM C578, Type IV, 1.45 lb/cu. ft. minimum density, 25 psi minimum compressive strength, square edged.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. DuPont
b. Kingspan Insulation LLC
c. Owens Corning
d. Soprema, Inc.

2. Thermal Resistance: R-value of 5.0 per 1 inch.
3. Size: 48 by 48 inches.
4. Thickness:

a. Base Layer: 1-1/2 inches.

C. Roof Insulation Accessories, General: As recommended in writing by insulation manufacturer for intended use and compatibility with other roofing system components.

1. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate to another insulation layer as follows:

a. Full-spread, spray-applied, low-rise, two-component urethane adhesive.

2. Insulation Fasteners: Insulation manufacturer's standard factory-coated steel fasteners with metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.
3. Induction-Welding Plates: Minimum 3-inch diameter with recessed center, 0.034-inch thick, aluminum-zinc-alloy-coated steel plates, factory coated with adhesive formulated for roof membrane, with corresponding corrosion-resistant fasteners.

2.5 COVER BOARD

A. General: Cover board as recommended in writing by roofing membrane manufacturer for intended use and compatible with other roofing system components.

B. Glass-Mat Gypsum Cover Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**CertainTeed; SAINT-GOBAIN**]
    b. [**Georgia-Pacific Gypsum LLC**]
    c. [**Gold Bond Building Products, LLC provided by National Gypsum Company**]
    d. [**USG Corporation**]
    e. <**Insert manufacturer's name**>

2. Thickness: 1/4 inch.
3. Surface Finish: Fiberglass facer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Roofing System Installer present, for compliance with requirements and other conditions affecting performance of the Work.

1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation in accordance with roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

3.3 INSTALLATION OF THERMOPLASTIC-POLYOLEFIN (TPO) ROOFING SYSTEM, GENERAL

A. Install roofing system materials and components in accordance with roofing system manufacturer's written installation instructions, FM Approvals' RoofNav listed roof assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.

B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning Work on adjoining roofing.

3.4 INSTALLATION OF ROOF INSULATION AND ACCESSORIES

A. Coordinate installation of roofing system components so insulation is not exposed to precipitation or left exposed at end of workday.

B. Comply with roofing system and insulation manufacturer's written installation instructions. Install minimum of two layers of insulation under area of roofing to achieve required thickness.

C. Install each layer of insulation with joints staggered not less than 24 inches in adjacent rows and offset not less than 12 inches from previous layer.

1. Trim insulation neatly to fit around penetrations and projections, and to fit tightly to intersecting sloping roof decks.
2. Make joints between adjacent insulation boards not more than 1/4 inch in width.
3. At internal roof drains, slope insulation to create a square drain sump, with each side equal to the diameter of the drain bowl plus 24 inches.
4. Trim insulation, so that water flow is unrestricted.
5. Fill gaps exceeding 1/4 inch with insulation.
6. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
7. Secure insulation to resist specified uplift pressure at corners, perimeter, and field of roof.
8. Place thermal spacers and plates on insulation in required fastening patterns to achieve FM rating and secure in accordance with manufacturer's instructions.

    a. Install plates and fasteners tight and flat to substrate with no dimpling, and with fastener extending 1 inch minimum into roof deck; do not overdrive fasteners.

9. Loosely lay each layer of insulation over substrate.

3.5 INSTALLATION OF COVER BOARD

A. Install cover board over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction.

1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
2. Cut and fit cover board tight to nailers, projections, and penetrations.
3. Adhere cover board to substrate in accordance with FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29.

B. Install slip sheet over cover board and beneath roofing membrane.

C. Place plates on cover board in required fastening patterns to achieve FM rating and secure in accordance with roofing system manufacturer’s written installation instructions.

1. Install plates and fasteners tight and flat to substrate with no dimpling, and with fastener extending 1 inch minimum into roof deck; do not overdrive fasteners.

3.6 INSTALLATION OF TPO ROOFING MEMBRANE

A. Unroll roofing membrane and allow it to relax before installing.

B. Accurately align roofing membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps. Apply roofing membrane with side laps shingled with slope of roof deck where possible.

C. Adhered Application: Apply bonding adhesive to substrate and underside of roofing membrane at rate required by manufacturer and allow to partially dry before installing roofing membrane. Do not apply to splice area of roofing membrane.

1. In addition to adhering, mechanically fasten roofing membrane securely at terminations, penetrations, and perimeter of roof area.

D. Mechanically Attached Application: Secure roofing membrane over area to receive roofing in accordance with roofing system manufacturer's written installation instructions.

1. Mechanically fasten or adhere roof membrane securely at terminations, penetrations, and perimeter of roofing.
2. Induction-Weld Attachment: Secure roofing membrane to plates creating 100 percent bond between underside of membrane and top of plates; a partial bond is unacceptable. Test welds to verify adhesion of roofing membrane to top of plates in accordance with manufacturer’s instructions.

E. Seams and End Laps: Clean seam areas, overlap membrane, and hot-air-weld side seams and end laps of roofing membrane and sheet flashings to ensure a watertight installation.

1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roofing membrane and sheet flashings.
2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.

3. Repair tears, voids, and lapped seams in roofing membrane that do not comply with requirements.

F. Spread sealant bed over deck-drain flange at roof drains, and securely seal roofing membrane in place with clamping ring.

3.7 INSTALLATION OF BASE AND SHEET FLASHINGS

A. General: Install and adhere base and sheet flashing and preformed flashing accessories to substrates in accordance with roofing system manufacturer's written installation instructions.

B. Apply bonding adhesive to substrate and underside of flashings at required rate and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners.

D. Clean seam areas, overlap, and firmly roll flashings into the adhesive. Hot-air-weld side seams and end laps to ensure a watertight installation.

E. Terminate and seal top of flashings and mechanically anchor to substrate through termination bars.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspect substrate conditions, surface preparation, and installation of roofing membrane, flashings, protection, and drainage components, and to furnish reports to Architect.

B. Perform the following tests:

1. Flood Testing: Flood test each roof area for leaks, in accordance with recommendations in ASTM D5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.

    a. Flood to an average depth of 2-1/2 inches with a minimum depth of 1 inch and not exceeding a depth of 4 inches. Maintain 2 inches of clearance from top of base flashing.
    b. Flood each area for 48 hours.
    c. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.

        1) Cost of retesting is Contractor's responsibility.

    d. Testing agency to prepare survey report indicating locations of initial leaks, if any, and final survey report.

C. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare

inspection report.

D. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.9 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing system, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.10 ROOFING SYSTEM INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called the "Roofing System Installer," has performed roofing and associated Work on the following Project:

1. Owner: <**Insert name of Owner**>.
2. Owner Address: <**Insert address**>.
3. Building Name/Type: <**Insert information**>.
4. Building Address: <**Insert address**>.
5. Area of Work: <**Insert information**>.
6. Acceptance Date: _____.
7. Warranty Period: [**Two**][**Five**]<**Insert number**> years from date of Substantial Completion.
8. Date of Substantial Completion: _____.

B. AND WHEREAS Roofing System Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said Work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing System Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period Roofing Installer will, at Roofing System Installer's own cost and expense, make or cause to be made such repairs to or replacements of said Work as are necessary to correct faulty and defective work and as are necessary to maintain said Work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to Work and other parts of the building, and to building contents, caused by:

    a. lightning;
    b. peak gust wind speed exceeding <**Insert mph**>;
    c. fire;
    d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
    e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the Work;
    f. vapor condensation on bottom of roofing; and
    g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.

2. When Work has been damaged by any of foregoing causes, Warranty will be null and void until such damage has been repaired by Roofing System Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
3. Roofing System Installer is responsible for damage to Work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of Work.
4. During Warranty Period, if Owner allows alteration of Work by anyone other than Roofing System Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty will become null and void on date of said alterations, but only to the extent said alterations affect Work covered by this Warranty. If Owner engages Roofing System Installer to perform said alterations, Warranty will not become null and void unless Roofing System Installer, before starting said Work, will have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate Work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty will become null and void on date of said change, but only to the extent said change affects Work covered by this Warranty.
6. Owner will promptly notify Roofing System Installer of observed, known, or suspected leaks, defects, or deterioration and afford reasonable opportunity for Roofing System Installer to inspect Work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing System Installer on said Work and will not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty will not operate to relieve Roofing System Installer of responsibility for performance of original Work in accordance with requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 07 54 23

SECTION 07 62 00 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Custom flashing and trim fabrications, made from the following:

1. Sheet metal materials.
2. Underlayment.
3. Miscellaneous materials.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section 075423 "Thermoplastic-Polyolefin (TPO)" for materials andinstallation of sheet metal flashing and trim integral with roofing.
3. Section 074213.13 "Formed Metal Wall Panels" for sheet metal flashing and trim integral with metal wall panels.
4. Section 077100 "Roof Specialties" for manufactured copings, roof-edge specialties, roof-edge drainage systems, reglets, and counterflashings.
5. Section 077200 "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.

1.2 COORDINATION

A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.

B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review special roof details, roof drainage, roof-penetration flashing, equipment curbs, and condition of other construction that affect sheet metal flashing and trim.
3. Review requirements for insurance and certificates if applicable.
4. Review sheet metal flashing observation and repair procedures after flashing installation.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For sheet metal flashing and trim.

1. Plans, elevations, sections, and attachment details.
2. Fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.
3. Identification of material, thickness, weight, and finish for each item and location in Project.
4. Details for forming, including profiles, shapes, seams, and dimensions.
5. Details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
6. Details of termination points and assemblies.
7. Details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
8. Details of roof-penetration flashing.
9. Details of edge conditions, including eaves, ridges, valleys, rakes, crickets, flashings, and counterflashings.
10. Details of special conditions.
11. Details of connections to adjoining work.

C. Samples: For each exposed product and for each color and texture specified, 12 inches long by actual width.

1.5 INFORMATIONAL SUBMITTALS

A. Certificates: For each type of coping and roof edge flashing that is ANSI/SPRI/FM 4435/ES-1 tested and FM Approvals approved.

B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

C. Qualification Statements: For fabricator.

D. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sheet metal flashing and trim, and its accessories.

B. Special warranty.

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: Entity that employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

B. For roof edge flashings and copings that are ANSI/SPRI/FM 4435/ES-1 tested and FM Approvals approved, shop is to be listed as able to fabricate required details as tested and approved.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.

1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
2. Protect stored sheet metal flashing and trim from contact with water.

B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.9 WARRANTY

A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, are to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim are not to rattle, leak, or loosen, and are to remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. SPRI Wind Design Standard: Manufacture and install roof edge flashings and copings

tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting the following design pressure:

1. Design Pressure: As indicated on Drawings.

D. FM Approvals Listing: Manufacture and install roof edge flashings and copings that comply with requirements in FM Approvals 4471 as part of a roofing system and that are listed in FM Approvals' "Approval Guide" and approved for windstorm classification, Class 1A-90. Identify materials with name of fabricator and design approved by FM Approvals.

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 SHEET METAL MATERIALS

A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with minimum ASTM A653/A653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with minimum ASTM A792/A792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

1. Surface: Smooth, flat.
2. Exposed Coil-Coated Finish:

    a. Two-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

3. Color: As indicated on Drawings.
4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

2.3 UNDERLAYMENT

A. Synthetic Underlayment: Laminated or reinforced, woven polyethylene or polypropylene, synthetic roofing underlayment; bitumen free; slip resistant; suitable for high temperatures over 220 deg F; and complying with physical requirements of ASTM D226/D226M for Type I and Type II felts.

1. Source Limitations - Obtain underlayment from single source from singe manufacturer.

B. Self-Adhering, High-Temperature Sheet Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 30 mils thick, specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer when recommended by underlayment manufacturer.

1. Low-Temperature Flexibility: Passes after testing at minus 20 deg F or lower; ASTM D1970/D1970M.
2. Source Limitations - Obtain underlayment from single source from singe manufacturer.
3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Carlisle WIP Products; a brand of Carlisle Construction Materials
    b. Henry, a Carlisle Company (formerly Henry Company and Carlisle Coatings & Waterproofing Inc. brands)
    c. Owens Corning

C. Felt: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felt; nonperforated.

D. Slip Sheet: Rosin-sized building paper, 3 lb/100 sq. ft. minimum, of type required for application.

2.4 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.

1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.

    a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
    b. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.
    c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.

2. Fasteners for Zinc-Coated (Galvanized) or Aluminum-Zinc Alloy-Coated Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M.
3. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.

C. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.

D. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

E. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

2.5 FABRICATION, GENERAL

A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.

1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Fabrication Tolerances:

1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 ft. on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.

1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.

D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.

E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet

metal standard and by FM Global Property Loss Prevention Data Sheet 1-49 for application, but not less than thickness of metal being secured.

G. Seams:

1. Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
2. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.

H. Do not use graphite pencils to mark metal surfaces.

2.6 ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Hanging Gutters:

1. Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required.
2. Fabricate in minimum 96-inch- long sections.
3. Furnish flat-stock gutter brackets and flat-stock gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard, but with thickness not less than twice the gutter thickness.
4. Fabricate expansion joints, expansion-joint covers, gutter bead reinforcing bars, and gutter accessories from same metal as gutters. Shop fabricate interior and exterior corners.
5. Gutter Profile: Style B in accordance with cited sheet metal standard.
6. Expansion Joints: Butt type with cover plate.
7. Gutters with Girth 26 to 30 Inches (660 to 760 mm): Fabricate from the following materials:

    a. Galvanized Steel: 0.040 inch thick.

B. Downspouts: Fabricate rectangular downspouts to dimensions indicated on Drawings, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors.

1. Fabricated Hanger Style: Fig. 1-35B in accordance with SMACNA's "Architectural Sheet Metal Manual."
2. Fabricate from the following materials:

    a. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.

C. Parapet Scuppers: Fabricate scuppers to dimensions required, with closure flange trim to exterior, 4-inch- wide wall flanges to interior, and base extending 4 inches beyond cant or tapered strip into field of roof. Fabricate from the following materials:

1. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.

D. Conductor Heads: Fabricate conductor heads with flanged back and stiffened top edge

and of dimensions and shape required, complete with outlet tubes, exterior flange trim,. Fabricate from the following materials:

1. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.

E. Splash Pans: Fabricate to dimensions and shape required and from the following materials:

1. Aluminum: 0.040 inch thick.

2.7 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Roof Edge Flashing (Gravel Stop) and Fascia Cap: Fabricate in minimum 96-inch-long, but not exceeding 12 ft. long sections. Furnish with 6-inch- wide, joint cover plates. Shop fabricate interior and exterior corners.

1. Joint Style: Butted with expansion space and 6-inch- wide, concealed backup plate.
2. Fabricate from the following materials:

a. Aluminum-Zinc Alloy-Coated Steel: [**0.028 inch**]<**Insert dimension**> thick.

B. Copings: Fabricate in minimum 96-inch- long, but not exceeding 12 ft.- long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and drill elongated holes for fasteners on interior leg. Miter corners, fasten and seal watertight. Shop fabricate interior and exterior corners.

1. Coping Profile: Fig. 3-4A in accordance with SMACNA's "Architectural Sheet Metal Manual."
2. Joint Style: Butted with expansion space and 6-inch- wide, concealed backup plate.
3. Fabricate from the following materials:

a. Aluminum-Zinc Alloy-Coated Steel: 0.040 inch thick.

C. Base Flashing: Shop fabricate interior and exterior corners.Fabricate from the following materials:

1. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.

D. Counterflashing: Shop fabricate interior and exterior corners.Fabricate from the following materials:

1. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.

E. Flashing Receivers: Fabricate from the following materials:

1. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.

F. Roof-Penetration Flashing: Fabricate from the following materials:

1. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.

2.8 WALL SHEET METAL FABRICATIONS

A. Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch- long, but not exceeding 12 ft. long, sections, under copings, and at shelf angles. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches beyond each side of wall openings; and form with 2-inch- high, end dams. Fabricate from the following materials:

1. Stainless Steel: 0.0156 inch thick.

B. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings. Form head and sill flashing with 2-inch- high, end dams. Fabricate from the following materials:

1. Stainless Steel: 0.0156 inch thick.

2.9 MISCELLANEOUS SHEET METAL FABRICATIONS

A. Equipment Support Flashing: Fabricate from the following materials:

1. Stainless Steel: 0.0188 inch thick.

B. Overhead-Piping Safety Pans: Fabricate from the following materials:

1. Stainless Steel: 0.0250 inch thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrates, and other conditions affecting performance of the Work.

1. Verify compliance with requirements for installation tolerances of substrates.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
3. Verify that air- or water-resistant barriers have been installed over substrate to prevent air infiltration or water penetration.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT

A. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, in accordance

with manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.

1. Lap horizontal joints not less than 4 inches.
2. Lap end joints not less than 12 inches.

B. Self-Adhering, High-Temperature Sheet Underlayment:

1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
2. Prime substrate if recommended by underlayment manufacturer.
3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
4. Apply in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses.
5. Overlap side edges not less than 3-1/2 inches. Roll laps and edges with roller.
6. Roll laps and edges with roller.
7. Cover underlayment within 14 days.

C. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim.

1. Install in shingle fashion to shed water.
2. Lap joints not less than 2 inches.

D. Install slip sheet, wrinkle free, over underlayment before installing sheet metal flashing and trim.

1. Install in shingle fashion to shed water.
2. Lapp joints not less than 4 inches.

3.3 INSTALLATION OF SHEET METAL FLASHING AND TRIM, GENERAL

A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.

1. Install fasteners, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of sealant.
3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
5. Install continuous cleats with fasteners spaced not more than 12 inches o.c.
6. Space individual cleats not more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
7. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.

8. Do not field cut sheet metal flashing and trim by torch.
9. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.

1. Coat concealed side of uncoated-aluminum sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.

1. Space movement joints at maximum of 10 ft. with no joints within 24 inches of corner or intersection.
2. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.

D. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

F. Seal joints as required for watertight construction.

1. Use sealant-filled joints unless otherwise indicated.

a. Embed hooked flanges of joint members not less than 1 inch into sealant.
b. Form joints to completely conceal sealant.
c. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way.
d. Adjust setting proportionately for installation at higher ambient temperatures.

1) Do not install sealant-type joints at temperatures below 40 deg F.

2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

3.4 INSTALLATION OF ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Install sheet metal roof-drainage items to produce complete roof-drainage system in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.

B. Hanging Gutters:

1. Join sections with riveted and soldered joints.
2. Provide for thermal expansion.
3. Attach gutters at eave or fascia to firmly anchor them in position.
4. Provide end closures and seal watertight with sealant.
5. Slope to downspouts.
6. Fasten gutter spacers to front and back of gutter.
7. Anchor and loosely lock back edge of gutter to continuous eave or apron flashing.
8. Anchor gutter with gutter brackets andstraps spaced not more than 36 inches apart to roof deck unless otherwise indicated, and loosely lock to front gutter bead.
9. Install gutter with expansion joints at locations indicated on Drawings, but not exceeding, 50 ft. apart. Install expansion-joint caps.

C. Downspouts:

1. Join sections with 1-1/2-inch telescoping joints.
2. Provide hangers with fasteners designed to hold downspouts securely to walls.
3. Locate hangers at top and bottom and at approximately 60 inches o.c.
4. Provide elbows at base of downspout to direct water away from building.
5. Connect downspouts to underground drainage system.

D. Splash Pans:

1. Install where downspouts discharge on low-slope roofs.
2. Set in elastomeric sealant compatible with the substrate.

E. Parapet Scuppers:

1. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
2. Anchor scupper closure trim flange to exterior wall and seal with elastomeric sealant to scupper.
3. Loosely lock front edge of scupper with conductor head.
4. seal with elastomeric sealant exterior wall scupper flanges into back of conductor head.

F. Conductor Heads: Anchor securely to wall, with elevation of conductor head rim at minimum of 1 inch below scupper discharge.

G. Expansion-Joint Covers: Install expansion-joint covers at locations and of configuration indicated on Drawings. Lap joints minimum of 4 inches in direction of water flow.

3.5 INSTALLATION OF SLOPED ROOF SHEET METAL FABRICATIONS

A. Install sheet metal flashing and trim to comply with performance requirements and cited sheet metal standard.

1. Provide concealed fasteners where possible, and set units true to line, levels, and slopes.
2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

B. Roof Edge Flashing:

1. Install roof edge flashings in accordance with ANSI/SPRI/FM 4435/ES-1.
2. Anchor to resist uplift and outward forces in accordance with recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch centers.

C. Copings:

1. Install copings in accordance with ANSI/SPRI/FM 4435/ES-1.
2. Anchor to resist uplift and outward forces in accordance with recommendations in cited sheet metal standard unless otherwise indicated.

    a. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at 24-inch centers.
    b. Anchor interior leg of coping with washers and screw fasteners through slotted holes at 24-inch centers.

3. Anchor to resist uplift and outward forces in accordance with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for specified FM Approvals' listing for required windstorm classification.

D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches over base flashing. Install stainless steel draw band and tighten.

E. Counterflashing: Coordinate installation of counterflashing with installation of base flashing.

1. Extend counterflashing 4 inches over base flashing.
2. Lap counterflashing joints minimum of 4 inches.
3. Secure in waterproof manner by means of snap-in installation and sealant or lead wedges and sealant unless otherwise indicated.

F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

3.6 INSTALLATION OF WALL SHEET METAL FABRICATIONS

A. Install sheet metal wall flashing to intercept and exclude penetrating moisture in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

B. Opening Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings.

3.7 INSTALLATION OF MISCELLANEOUS SHEET METAL FABRICATIONS

A. Equipment Support Flashing:

1. Coordinate installation of equipment support flashing with installation of roofing and equipment.
2. Weld or seal flashing with elastomeric sealant to equipment support member.

B. Overhead-Piping Safety Pans:

1. Suspend pans from structure above, independent of other overhead items such as equipment, piping, and conduit, unless otherwise indicated on Drawings.
2. Pipe and install drain line to plumbing waste or drainage system.

3.8 INSTALLATION TOLERANCES

A. Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 ft. on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.9 CLEANING

A. Clean and neutralize flux materials. Clean off excess solder.

B. Clean off excess sealants.

3.10 PROTECTION

A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

B. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended in writing by sheet metal flashing and trim manufacturer.

C. Maintain sheet metal flashing and trim in clean condition during construction.

D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

END OF SECTION 07 62 00

SECTION 07 71 00 - ROOF SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Manufactured units for the following applications:

1. Roof-edge specialties.
2. Roof-edge drainage systems.
3. Underlayment.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for downspout guards and downspout boots.
2. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
3. Section 076200 "Sheet Metal Flashing and Trim" for custom- and site-fabricated, sheet metal flashing and trim.
4. Section 077253 "Snow Guards" for prefabricated devices designed to hold snow on the roof surface, allowing it to melt and drain off slowly.
5. Section 079200 "Joint Sealants" for field-applied sealants between roof specialties and adjacent materials.
6. Section 099113 "Exterior Painting" for field painting of roof specialties.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, roofing-system testing and inspecting agency representative, roofing Installer, roofing-system manufacturer's representative, Installer, structural-support Installer, and installers whose work interfaces with or affects roof specialties, including installers of roofing materials and accessories.
2. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
3. Review special roof details, roof drainage, and condition of other construction that will affect roof specialties.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of roof specialty.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For roof specialties.

1. Plans, expansion-joint locations, keyed details, and attachments to other work. Distinguish between factory pre manufactured- and field-assembled installation.
2. Details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.
3. Indicate profile and pattern of seams and layout of fasteners, cleats, clips, and other attachments.
4. Details of termination points and assemblies, including fixed points.
5. Details of special conditions.

C. Samples: For each type of roof specialty and for each color and texture specified.

D. Samples for Initial Selection: For each type of roof specialty indicated with factory-applied color finishes.

E. Samples for Verification:

1. Include Samples of each type of roof specialty to verify finish and color selection, in manufacturer's standard sizes.
2. Include roof-edge drainage systems made from 12-inch lengths of full-size components in specified material, and including fasteners, cover joints, accessories, and attachments.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of roof specialty roof-edge flashings that is ANSI/SPRI/FM 4435/ES-1 tested.

B. Product Test Reports: For roof-edge flashings, for tests performed by a qualified testing agency.

C. Research Reports: For roof-edge flashings, from an agency acceptable to authorities having jurisdiction showing compliance with ANSI/SPRI/FM 4435/ES-1.

D. Qualification Statements: For manufacturer.

E. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roof specialties.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer offering products that are FM Approvals listed for specified class.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.

B. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof-specialty installation.

1.8 FIELD CONDITIONS

A. Field Measurements: Verify profiles and tolerances of roof-specialty substrates by field measurements before fabrication, and indicate measurements on Shop Drawings.

1.9 COORDINATION

A. Coordinate roof specialties with roofing system, exterior wall system, air barrier, flashing, trim, and construction of parapets, roof deck, roof and wall panels, and other adjoining work to provide a leakproof, weathertight, secure, and noncorrosive installation.

1. Performance Coordination: Coordinate with the Work of roofing and exterior wall Sections to ensure that roof specialties provided under the Work of this Section meet or exceed specified roofing and exterior wall design performance requirements.

B. Confirm and coordinate compatibility of materials and comply with warranty requirements of roofing system manufacturer.

C. Coordinate roof specialties layout and seams with sizes and locations of joints and seams in adjacent materials.

1.10 WARRANTY

A. Special Warranty on Painted Finishes: Manufacturer agrees to repair finishes or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:

   a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
   b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
   c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Roof specialties to withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

B. SPRI Wind Design Standard: Manufacture and install roof-edge specialties tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting the following design pressures:

1. Design Pressure: As indicated on Drawings.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 ROOF-EDGE SPECIALTIES

A. Roof-Edge Fascia: Manufactured, two-piece, roof-edge fascia consisting of snap-on metal fascia cover in section lengths not exceeding 12 ft. and a continuous metal receiver with integral drip-edge cleat to engage fascia cover. Provide matching corner units.

1. Fascia Accessories: Fascia extenders with continuous hold-down cleats andSoffit trim.
2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Berridge Manufacturing Company
b. Hickman; an MTL Company
c. Metal-Era, Inc.

3. Metallic-Coated Steel Fascia Covers: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, nominal thickness as required to meet performance requirements.

a. Surface: Smooth, flat finish.
b. Finish: Three-coat fluoropolymer.
c. Color: As selected by Architect from manufacturer's full range.

4. Corners: Factory mitered and mechanically clinched and sealed watertight.
5. Splice Plates: Concealed, of same material, finish, and shape as fascia cover.
6. Receiver: Manufacturer's standard material and thickness.

B. General - Refer to product indicated on Drawings.

C. Refer to product indicated on Drawings.

2.3 ROOF-EDGE DRAINAGE SYSTEMS

A. General: Refer to product indicated on Drawings.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Architectural Products Company
2. Hickman; an MTL Company
3. Metal-Era, Inc.

C. Gutters: Manufactured in uniform section lengths not exceeding 12 ft., with matching corner units, ends, outlet tubes, and other accessories. Elevate back edge at least 1 inch above front edge. Furnish flat-stock gutter straps, gutter brackets, expansion joints, and expansion-joint covers fabricated from same metal as gutters.

1. Metallic-Coated Steel Sheet: Nominal 0.034-inch thickness.
2. Gutter Profile: Style K in accordance with SMACNA's "Architectural Sheet Metal Manual."
3. Corners: Factory mitered and mechanically clinched and sealed watertight.
4. Gutter Supports: Manufacturer's standard supports as selected by Architect with finish matching the gutters.

D. Downspouts: Plain rectangular complete with [**machine-crimped**][**mitered**][**smooth-curve**] elbows, manufactured from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and anchors.

1. Metallic-Coated Steel Sheet: Nominal 0.034-inch thickness.
2. Size: As indicated on Drawings.

E. Finishes:

1. Metallic-Coated Steel: Three-coat fluoropolymer.

a. Color: As selected by Architect from manufacturer's full range.

2.4 SHEET METAL MATERIALS

A. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with minimum ASTM A653/A653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with minimum ASTM A792/A792M, Class AZ50 coating

designation; structural quality..

1. Mill-Phosphatized Finish: Manufacturer's standard for field painting.
2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.
3. Exposed Coil-Coated Finish: Prepainted by the coil-coating process to comply with ASTM A755/A755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

    a. Two-Coat Fluoropolymer Finish: AAMA 2605. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight in color coat.

4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.

B. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.

2.5 UNDERLAYMENT

A. Felt: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felt, nonperforated.

B. Slip Sheet: Rosin-sized building paper, 3-lb/100 sq. ft. minimum.

2.6 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Fasteners: Roof specialty manufacturer's recommended fasteners, designed to meet performance requirements, suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:

1. Fasteners for Metallic-Coated Steel Sheet: Series 300 stainless steel or hot-dip zinc-coated steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M.
2. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
3. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.

C. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.

D. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant of type, grade,

class, and use classifications required by roofing-specialty manufacturer for each application.

E. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type joints with limited movement.

F. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

G. Asphalt Roofing Cement: ASTM D4586, asbestos free, of consistency required for application.

2.7 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM/NOMMA AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.

C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage where applicable, and securely anchored.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install roof specialties in accordance with manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, underlayments, sealants, and other miscellaneous items as required to complete roof-specialty systems.

1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.

2. Provide uniform, neat seams with minimum exposure of solder and sealant.
3. Install roof specialties to fit substrates and to result in weathertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
4. Torch cutting of roof specialties is not permitted.
5. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer's written installation instructions.

1. Coat concealed side of uncoated aluminum and stainless steel roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.

C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.

1. Space movement joints at a maximum of 12 ft. with no joints within 18 inches of corners or intersections unless otherwise indicated on Drawings.
2. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.

D. Fastener Sizes: Use fasteners of sizes that penetrate substrate not less than recommended in writing by fastener manufacturer to achieve maximum pull-out resistance.

E. Seal concealed joints with butyl sealant as required by roof specialty manufacturer.

F. Seal joints as required for weathertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F.

3.3 INSTALLATION OF ROOF-EDGE SPECIALTIES

A. Install cleats, cants, and other anchoring and attachment accessories and devices with concealed fasteners.

B. Anchor roof edgings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.

3.4 INSTALLATION OF ROOF-EDGE DRAINAGE SYSTEMS

A. Install components to produce a complete roof-edge drainage system in accordance with manufacturer's written instructions. Coordinate installation of roof perimeter flashing with installation of roof-edge drainage system.

B. Gutters: Join and seal gutter lengths. Allow for thermal expansion. Attach gutters to

firmly anchored gutter supports spaced not more than 24 inches apart. Attach ends with rivets and seal with sealant to make watertight. Slope to downspouts.

1. Install gutter with expansion joints at locations indicated but not exceeding 50 ft. apart. Install expansion-joint caps.

C. Downspouts: Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c.

1. Connect downspouts to underground drainage system indicated.

D. Splash Pans: Install where downspouts discharge on low-slope roofs. Set in elastomeric sealant.

E. Conductor Heads: Anchor securely to wall with elevation of conductor top edge 1 inch below scupper discharge.

3.5 CLEANING AND PROTECTION

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing in accordance with ASTM A780/A780M.

B. Clean and neutralize flux materials. Clean off excess solder and sealants.

C. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.

D. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures, as determined by Architect.

END OF SECTION 07 71 00

SECTION 07 72 53 - SNOW GUARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rail-type, seam-mounted snow guards.

1.2 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

1. Rail-type, seam-mounted snow guards.

B. Shop Drawings: Include roof plans showing layouts and attachment details of snow guards.

1. Include details of rail-type snow guards.

C. Samples:

1. Pad-Type Snow Guards: Full-size unit with installation hardware.

a. For units with factory-applied finishes, submit manufacturer's standard color selections.

D. Delegated Design Submittals: For snow guards, include analysis reports signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include calculation of number and location of snow guards.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that the engineer is licensed in the state in which the Project is located.

B. Product Test Reports: For each type of snow guard, for tests performed by a qualified testing agency, indicating load at failure of attachment to roof system identical to roof system used on this Project.

1.4 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit adhesive-mounted snow guards to be installed, and adhesive cured, according to adhesive manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design snow guards, including attachment to roofing material and roof deck, as applicable for attachment method, based on the following:

1. Roof snow load.
2. Snow drifting
3. Roof slope.
4. Roof type.
5. Roof dimensions.
6. Roofing substrate type and thickness.
7. Snow guard type.
8. Snow guard fastening method and strength.
9. Snow guard spacing.
10. Coefficient of Friction Between Snow and Roof Surface: 0.
11. Factor of Safety: 2.

B. Performance Requirements: Provide snow guards that withstand exposure to weather and resist thermally induced movement without failure, rattling, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

C. Structural Performance: Snow guards to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Snow Loads: As indicated on Drawings.

2.2 RAIL-TYPE SNOW GUARDS

A. Rail-Type, Seam-Mounted Snow Guards:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Alpine SnowGuards
b. IceBlox Inc.

c. Rocky Mountain Snow Guards, Inc.

2. Description: Snow guard rails fabricated from metal pipes, bars, or extrusions, anchored to brackets and equipped with one rail.
3. Brackets and Baseplate: ASTM B209 aluminum; mill finished orASTM B209 aluminum; clear anodized.
4. Bars: ASTM B221 aluminum; mill finish orASTM B221 aluminum, clear anodized.

   a. Profile: Round orSquare.

5. Seam Clamps: ASTM B221 aluminum extrusion or ASTM B85/B85M aluminum casting with stainless steel set screws incorporating round nonpenetrating point; designed for use with applicable roofing system to which clamp is attached.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, snow guard attachment, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install snow guards according to manufacturer's written instructions.

1. Space rows as recommended by manufacturer.

B. Attachment for Standing-Seam Metal Roofing:

1. Do not use fasteners that will penetrate metal roofing or fastening methods that void metal roofing finish warranty.
2. Rail-Type, Seam-Mounted Snow Guards:

   a. Install brackets to vertical ribs in straight rows.
   b. Secure with stainless steel set screws, incorporating round nonpenetrating point, on same side of standing seam.
   c. Torque set screw in accordance with manufacturer's written instructions.
   d. Install cross members to brackets.

C. Attachment for Exposed Fastened Metal Roofing:

1. Do not use fasteners that will void metal roofing finish warranty.
2. Rail-Type, Flat-Mounted Snow Guards:

   a. Install brackets in straight rows.

b. Mechanically fasten to metal roofing, using sealant and mechanical fasteners identical to those used to secure metal roofing to substrate.
c. Install cross members to brackets.

END OF SECTION 07 72 53

SECTION 07 84 13 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Penetration firestopping systems.

B. Related Requirements:

1. Section 078443 "Joint Firestopping" for joints in or between fire-resistance-rated construction, at exterior curtain-wall/floor intersections, and in smoke barriers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.

C. Unlisted Firestopping Systems: Obtain an Engineering Judgment (EJ) from firestopping manufacturer where no UL, FM Approvals, or other listed assembly is available for particular firestop configuration. Follow International Firestop Council (IFC) recommended guidelines for evaluating firestopping systems in EJs.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly developed in accordance with current International Firestop Council (IFC) recommended guidelines. Obtain approval of authorities having jurisdiction prior to submittal.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Listed System Designs: For each penetration firestopping system, for tests performed by a qualified testing agency.

1.4 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Entity that has been approved by FM Approvals in accordance with FM Approvals 4991 or been evaluated by UL Solutions and found to comply with "UL Solutions Qualified Firestop Contractor Program."

1.6 FIELD CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping systems when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping system materials in accordance with manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.7 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be accessed and installed in accordance with specified firestopping system design.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain penetration firestopping systems for each type of opening indicated from single manufacturer.

2.2 PENETRATION FIRESTOPPING SYSTEMS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. 3M Building and Construction
2. Tremco Incorporated

B. Penetration firestopping systems must be compatible with one another, with the substrates forming openings, and with penetrating items if any.

1. Penetration firestopping systems must be installed with products bearing the classification marking of a qualified testing agency.

a. UL Solutions in its online directory "Product iQ."
b. Intertek Group in its "Directory of Building Products."

2. Provide components for each penetration firestopping system that, upon curing, do not re-emulsify, dissolve, leach, break down, or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water, or other forms of moisture characteristic during and after construction.
3. Provide components for each penetration firestopping system that do not contain ethylene glycol.
4. Provide components for each penetration firestopping system that are sufficiently flexible to accommodate movement, such as pipe vibration, water hammer, thermal expansion, and other normal building movement without damage.
5. Provide components for each penetration firestopping system that are appropriately tested for the thickness and type of insulation utilized.

C. Provide penetration firestopping systems that resist spread of fire, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.

D. Penetration Firestopping Systems in Fire-Resistance-Rated Walls: Systems with ratings determined in accordance with ASTM E814 or UL 1479.

1. F-Rating: Not less than the fire-resistance rating of the wall assembly penetrated.
2. Membrane Penetrations: Install recessed fixtures such that the required fire resistance will not be reduced.

E. Penetration Firestopping Systems in Horizontal Assemblies: Systems with ratings determined in accordance with ASTM E814 or UL 1479.

1. F-Rating: At least one hour, but not less than the fire-resistance rating of the floor/ceiling assembly penetrated.
2. T-Rating: At least one hour, but not less than the fire-resistance rating of the floor/ceiling assembly. The following horizontal penetrations do not require a T-rating:

a. Those within the cavity of a wall.
b. Floor, tub, or shower drains within a concealed space.
c. 4-inch or smaller metal conduit penetrating directly into metal-enclosed electrical switchgear.

3. W-Rating: Provide penetration firestopping systems with a Class 1 W-rating in accordance with UL 1479.

F. Penetration Firestopping Systems in Smoke Barriers: Systems with ratings determined in accordance with UL 1479.

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening and no more than 50-cfm cumulative total for any 100 sq. ft. at both ambient and elevated temperatures.

G. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed

indexes of less than 25 and 450, respectively, when tested in accordance with ASTM E84 or UL 723.

2.3 ACCESSORIES

A. Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated, including but not limited to:

1. Permanent forming/damming/backing materials.
2. Substrate primers.
3. Collars.
4. Steel sleeves.

2.4 FILL MATERIALS

A. Cast-in-Place Firestopping Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer sleeve lined with an intumescent strip, a flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

C. Firestopping Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced intumescent elastomeric sheet bonded to galvanized-steel sheet.

E. Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.

F. Intumescent Wrap Strips: Single-component intumescent elastomeric strips for use around combustible penetrants.

G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

H. Pillows/Bags: Compressible, removable, and reusable intumescent pillows encased in fire-retardant polyester or glass-fiber cloth. Where exposed, and when required by a listed system, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed or dislodged.

I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric

sealants.

K. Fire-Rated Cable Sleeve Kits: Complete kits designed for new cable penetrations through walls which accept standard accessories.

L. Fire-Rated Cable Pathways: Single or gangable device modules composed of a steel raceway with integral intumescent material and requiring no additional action in the form of plugs, twisting closure, putty, pillows, sealant, or otherwise to achieve fire and air-leakage ratings.

1. Fire-rated cable pathway devices are the preferred product for data, video, and communications cable penetrations. Install these devices in locations where frequent cable moves, add-ons, and changes will occur. Such devices must be:

   a. Designed so that two or more devices can be ganged together.
   b. Maintenance-free so no action is required to activate the smoke- and fire-sealing mechanism.

2. Where fire-rated cable pathway devices are not practical, openings within walls and floors designed to accommodate data, video, and communications cabling must be provided with re-enterable products specifically designed for retrofit, such as retrofit devices for cable bundles, firestopping putty, plugs, or pillows.

M. Wall-Opening Protective Materials: Intumescent, non-curing putty pads or self-adhesive inserts for protection of electrical switch and receptacle boxes.

N. Fire-Rated HVAC Retaining Angles: Steel angle system with integral intumescent firestopping gasket for use around rectangular steel HVAC ducts without fire dampers.

O. Firestopping Plugs: Flexible, re-enterable, intumescent, foam-rubber plug for use in blank round openings and cable sleeves.

P. Fire-Rated Cable Grommet: Molded two-piece grommet made of plenum-grade polymer and foam inner core for sealing small cable penetrations in gypsum walls up to 1/2 inch in diameter.

Q. Closet Flange Gasket: Molded, single-component, flexible, intumescent gasket for use beneath a water closet (toilet) flange in floor applications.

2.5 MIXING

A. Penetration Firestopping Materials: For those products requiring mixing before application, comply with penetration firestopping system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings in accordance with manufacturer's written instructions and with the following requirements:

1. Remove foreign materials from substrate surfaces that could interfere with adhesion of penetration firestopping materials.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Prime substrates in accordance with penetration firestopping system manufacturer's written installation instructions, using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 INSTALLATION OF PENETRATION FIRESTOPPING SYSTEMS

A. General: Install penetration firestopping systems in accordance with manufacturer's written installation instructions and published drawings for products and applications.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.

C. Install fill materials by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items to achieve required fire-resistance ratings.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375-inch strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 ft. from end of wall and at intervals not exceeding 30 ft..

B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Owner will engage a qualified inspection agency to conduct and report on inspections in accordance with ASTM E2174.

B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.

C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping material and install new materials to produce systems complying with specified requirements.

END OF SECTION 07 84 13

SECTION 07 84 43 - JOINT FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Intumescent gypsum wall framing gaskets.
2. Joints in or between fire-resistance-rated construction.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetrations in fire-resistance-rated walls, horizontal assemblies, and smoke barriers and for wall identification.
2. Section 092216 "Non-Structural Metal Framing" for firestop tracks for metal-framed partition heads.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Product Schedule: For each joint firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing agency.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing agency's illustration for a particular joint firestopping system condition, submit illustration, with modifications marked, approved by joint firestopping system manufacturer's fire-protection engineer as an EJ or equivalent fire-resistance-rated assembly developed in accordance with current IFC guidelines.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Listed System Designs: For each joint firestopping system, for tests performed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written installation instructions.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Approvals in accordance with FM Approvals 4991 or been evaluated by UL and found to comply with UL's "UL Solutions Qualified Firestop Contractor Program."

1.7 FIELD CONDITIONS

A. Environmental Limitations: Do not install joint firestopping systems when ambient or substrate temperatures are outside limits permitted by joint firestopping system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Install and cure joint firestopping systems in accordance with manufacturer's written installation instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.8 COORDINATION

A. Coordinate construction of joints to ensure that joint firestopping systems can be installed in accordance with specified firestopping system design.

B. Coordinate sizing of joints to accommodate joint firestopping systems.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain joint firestop systems for each type of joint opening indicated from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. A qualified testing agency, acceptable to authorities having jurisdiction, will perform joint firestopping system tests.
2. Test in accordance with testing standards referenced in "Joint Firestopping Systems" Article. Provide rated systems complying with the following requirements:

a. Joint firestop systems installed with products bearing the classification marking of a qualified product certification agency in accordance with listed system designs published by a qualified testing agency.

1) UL in its online directory "Product iQ."

2.3 JOINT FIRESTOPPING SYSTEM TYPES

A. General: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems must accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

1. Joint firestopping systems that are compatible with one another, with the substrates forming openings, and with penetrating items, if any.
2. Provide products that, upon curing, do not re-emulsify, dissolve, leach, break down, or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture.
3. Provide firestop products that do not contain ethylene glycol.

B. Intumescent Gypsum Wall Framing Gaskets: Applied to steel tracks, runners, and studs prior to framing installation. Provide products with fire, smoke, and acoustical ratings that allow movement of up to 100 percent compression and/or extension when tested in accordance with UL 2079 or ASTM E1966; have an L Rating of less than 1 cfm/ft. when tested in accordance with UL 2079; and a minimum Sound Transmission Class (STC) rating of 56 when tested in accordance with ASTM E90 or ASTM C919.

C. Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined in accordance with ASTM E1966 or UL 2079, with published L-Ratings for ambient and elevated temperatures as evidence of the ability of the fire-resistive joint system to restrict the movement of smoke.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. 3M Building and Construction
b. Hilti, Inc.
c. Tremco Incorporated

2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.

D. Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined in accordance with ASTM E84.

2.4 ACCESSORIES

A. Provide components of joint firestopping systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Before installing joint firestopping systems, clean joints in accordance with fire-resistive joint system manufacturer's written installation instructions and the following requirements:

1. Remove foreign materials from substrate surfaces that could interfere with adhesion of elastomeric fill materials or compromise fire-resistive rating.
2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with elastomeric fill materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Prime substrates in accordance with joint firestopping system manufacturer's written installation instructions, using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Apply a suitable bond breaker to prevent three-sided adhesion in applications where condition occurs.

3.3 INSTALLATION

A. General: Install joint firestopping systems in accordance with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support elastomeric fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing elastomeric fill materials and allowing them to fully cure, remove

combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.

C. Install elastomeric fill materials for joint firestopping systems by proven techniques to produce the following results:

1. Apply elastomeric fill in voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
2. Apply elastomeric fill materials so they contact and adhere to substrates formed by joints.
3. For elastomeric fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Wall Identification: Permanently label walls containing firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375-inch strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 ft. from end of wall and at intervals not exceeding 30 ft..

B. Joint Identification: Identify joint firestopping systems with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of joint edge, so labels are visible to anyone seeking to remove joint firestopping system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Joint Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections in accordance with ASTM E2393.

B. Where deficiencies are found or joint firestopping systems are damaged or removed due to testing, repair or replace joint firestopping systems so they comply with requirements.

C. Proceed with enclosing joint firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess elastomeric fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by joint firestopping system manufacturers and that do not damage materials in which joints occur.

B. Provide final protection and maintain conditions during and after installation that ensure joint firestopping systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated joint firestopping systems immediately and install new materials to produce joint firestopping systems complying with specified requirements.

3.7 JOINT FIRESTOPPING SYSTEM SCHEDULE

A. Where UL-classified systems are indicated, they refer to system numbers in UL's online directory "Product iQ" under product Category XHBN Category XHDG.

B. Wall-to-Wall, Joint Firestopping Systems: ..

1. UL-Classified Systems: WW-D S-0000-0999.
2. Assembly Rating: One hour andTwo hours.
3. Nominal Joint Width: As indicated.
4. Movement Capabilities: Class I - 50 percent compression or extension.

C. Floor-to-Wall, Joint Firestopping Systems: ..

1. UL-Classified Systems: FW-S-0000-0999.
2. Assembly Rating: One hour andTwo hours.
3. Nominal Joint Width: As indicated.

D. Head-of-Wall, Fire-Resistive Joint Firestopping Systems: ..

1. UL-Classified Systems: HW-S-0000-0999.
2. Assembly Rating: One hour andTwo hours.
3. Nominal Joint Width: As indicated.
4. Movement Capabilities: Class I - 50 percent compression or extension.

END OF SECTION 07 84 43

SECTION 07 92 00 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Silicone joint sealants.
2. Nonstaining silicone joint sealants.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each product data.

B. Samples for Initial Selection: Manufacturer's standard color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Samples for Verification: For each type and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Authorized representative who is trained and approved by manufacturer.

1.4 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for

applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.5 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain joint sealants from single manufacturer for each sealant type.

2.2 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.3 SILICONE JOINT SEALANTS

A. Silicone, S, NS, 50, NT: Single-component, nonsag, plus 50 percent and minus 50

percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Adfast
    b. GE Construction Sealants; Momentive Performance Materials Inc.
    c. Pecora Corporation
    d. Sika Corporation - Building Components
    e. The Dow Chemical Company

B. Silicone, Acid Curing, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Adfast
    b. Pecora Corporation
    c. Sika Corporation - Building Components
    d. The Dow Chemical Company

C. Silicone, S, NS, 50, T, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Soudal Accumetric
    b. The Dow Chemical Company

D. Silicone, S, P, 100/50, T, NT: Single-component, pourable, plus 100 percent and minus 50 percent movement capability traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade P, Class 100/50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Pecora Corporation
    b. Sika Corporation

2.4 NONSTAINING SILICONE JOINT SEALANTS

A. Nonstaining Joint Sealants: No staining of substrates when tested in accordance with

ASTM C1248.

B. Silicone, Nonstaining, S, NS, 100/50, NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Adfast
b. Pecora Corporation
c. Sika Corporation - Building Components

C. Silicone, Nonstaining, S, NS, 50, NT: Nonstaining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Adfast
b. GE Construction Sealants; Momentive Performance Materials Inc.
c. Pecora Corporation
d. Sika Corporation - Building Components
e. The Dow Chemical Company

2.5 JOINT-SEALANT BACKING

A. Sealant Backing Material, General - Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.6 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of

sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

    a. Concrete.
    b. Masonry.
    c. Unglazed surfaces of ceramic tile.

3. Remove laitance and form-release agents from concrete.
4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

    a. Metal.
    b. Glass.
    c. Porcelain enamel.
    d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants in accordance with requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile in accordance with Figure 8A in ASTM C1193 unless otherwise indicated.

3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION 07 92 00

SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior standard steel doors and frames.
2. Exterior standard steel doors and frames.

B. Related Requirements:

1. Section 087100 "Door Hardware" for door hardware for hollow-metal doors.

1.2 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings in accordance with NAAMM-HMMA 803 or ANSI/SDI A250.8.

1.3 COORDINATION

A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Interior standard steel doors and frames.
2. Exterior standard steel doors and frames.

B. Product Data Submittals: For each product.

1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, temperature-rise ratings, and finishes.

C. Shop Drawings: Include the following:

1. Elevations of each door type.
2. Details of doors, including vertical- and horizontal-edge details and metal

thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
7. Details of anchorages, joints, field splices, and connections.
8. Details of accessories.
9. Details of moldings, removable stops, and glazing.

D. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For door inspector.

1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.
2. Egress Door Inspector: Submit documentation of compliance with NFPA 101, Section 7.2.1.15.4.
3. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAI) certificate.

B. Product Test Reports: For each type of fire-rated hollow-metal door and frame assembly and thermally rated door assemblies for tests performed by a qualified testing agency indicating compliance with performance requirements.

C. Oversize Construction Certification: For assemblies required to be fire-rated and exceeding limitations of labeled assemblies.

D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.7 QUALITY ASSURANCE

A. Fire-Rated Door Inspector Qualifications: Inspector for field quality-control inspections of fire-rated door assemblies is to meet the qualifications set forth in NFPA 80, Section 5.2.3.1 and the following:

1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

B. Egress Door Inspector Qualifications: Inspector for field quality-control inspections of

egress door assemblies is to meet the qualifications set forth in NFPA 101, Section 7.2.1.15.4 and the following:

1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

1. Provide additional protection to prevent damage to factory-finished units.

B. Store hollow-metal doors and frames vertically under cover at Project site with head up. Place on minimum 4-inch- high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 HOLLOW METAL DOORS AND FRAMES

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Ceco Door; AADG, Inc.; ASSA ABLOY
2. Curries, AADG, Inc.; ASSA ABLOY Group
3. Steelcraft; Allegion plc

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated on Drawings, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.

1. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.
2. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

B. Fire-Rated, Borrowed-Lite Assemblies: Assemblies complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing in accordance with NFPA 257 or UL 9.

C. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.50 deg Btu/F x h x sq. ft. when tested in accordance with ASTM C1363 or ASTM E1423.

2.3 INTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 2; ANSI/SDI A250.4, Level B.
.

1. Doors:

    a. Type: As indicated in the Door and Frame Schedule on Drawings.
    b. Thickness: 1-3/4 inches.
    c. Face: Uncoated steel sheet, minimum thickness of 0.042 inch.
    d. Edge Construction: Model 1, Full Flush.
    e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
    f. Core: Manufacturer's standard.
    g. Fire-Rated Core: Manufacturer's standard vertical steel stiffener core for fire-rated doors.

2. Frames:

    a. Materials: Uncoated steel sheet, minimum thickness of 0.053 inch.
    b. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
    c. Construction: Knocked down.

3. Exposed Finish: Prime.

2.4 EXTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 2; ANSI/SDI A250.4, Level B.
.

1. Doors:

    a. Type: As indicated in the Door and Frame Schedule on Drawings.
    b. Thickness: 1-3/4 inches.
    c. Face: Metallic-coated steel sheet, minimum thickness of 0.042 inch, with minimum A40 coating.
    d. Edge Construction: Model 1, Full Flush.

e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
g. Bottom Edges: Close bottom edges of doors with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
h. Core: Manufacturer's standard.
i. Fire-Rated Core: Manufacturer's standard vertical steel stiffener with insulation core for fire-rated doors.

2. Frames:

a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A40 coating.
b. Construction: Knocked down.

3. Exposed Finish: Prime.

2.5 BORROWED LITES

A. Fabricate of uncoated steel sheet, minimum thickness of 0.053 inch.

B. Construction: Knocked down.

C. Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as metal as frames.

D. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

2.6 HOLLOW-METAL PANELS

A. Provide hollow-metal panels of same materials, construction, and finish as adjacent door assemblies.

2.7 FRAME ANCHORS

A. Jamb Anchors:

1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches of frame height above 7 feet.
3. Postinstalled Expansion Anchor: Minimum 3/8-inch- diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.

B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.

C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at top of underlayment.

D. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized in accordance with ASTM A153/A153M, Class B.

2.8 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.

D. Inserts, Bolts, and Fasteners: Hot-dip galvanized in accordance with ASTM A153/A153M.

E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

F. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.

G. Glazing: Comply with requirements in Section 088000 "Glazing."

2.9 FABRICATION

A. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.

1. Sidelite and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding, or by rigid mechanical anchors.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Door Silencers: Except on weather-stripped frames, drill stops to receive door

silencers as follows. Keep holes clear during construction.

a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

B. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping in accordance with ANSI/SDI A250.6, the Door Hardware Schedule on Drawings, and templates.

1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

C. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.

1. Provide stops and moldings flush with face of door, and with [**beveled**][**square**] stops unless otherwise indicated.
2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.
4. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
5. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

2.10 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 PREPARATION

A. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

A. Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.

B. Hollow-Metal Frames: Comply with NAAMM-HMMA 840.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.

    a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
    b. Install frames with removable stops located on secure side of opening.

2. Fire-Rated Openings: Install frames in accordance with NFPA 80.
3. Floor Anchors: Secure with postinstalled expansion anchors.

    a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

4. Solidly pack mineral-fiber insulation inside frames.
5. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
6. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:

    a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
    c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

C. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.

1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8,,NAAMM-HMMA 841 and NAAMM-HMMA guide specification indicated.
2. Fire-Rated Doors: Install doors with clearances in accordance with NFPA 80.
3. Smoke-Control Doors: Install doors in accordance with NFPA 105.

D. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.

3.3 FIELD QUALITY CONTROL

A. Inspection Agency: Engage a qualified inspector to perform inspections and to furnish reports to Architect.

B. Inspections:

1. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, Section 5.2.
2. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements in accordance with NFPA 101, Section 7.2.1.15.

C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in NFPA 80 NFPA 101.

3.4 REPAIR

A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint in accordance with manufacturer's written instructions.

C. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 08 11 13

SECTION 08 31 13 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Recessed access doors with concealed flanges.

B. Related Requirements:

1. Section 233300 "Air Duct Accessories" for heating and air-conditioning duct access doors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details material descriptions, dimensions of individual components and profiles, and finishes.

B. Product Schedule: For access doors and frames.[**Use same designations indicated on Drawings.**]

PART 2 - PRODUCTS

2.1 ACCESS DOORS AND FRAMES

A. Recessed Access Doors with Concealed Flanges:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Babcock-Davis
b. JL Industries; Activar Construction Products Group, Inc.
c. Nystrom, Inc.

2. Description: Door face recessed 5/8 inch for gypsum board infill; with concealed flange for gypsum board installation and concealed hinge.
3. Optional Features: Piano hinges.
4. Locations: Ceiling.
5. Door Size: As indicated on Drawings.
6. Uncoated Steel Sheet for Door: Nominal 0.060 inch, 16 gage, factory primed.
7. Metallic-Coated Steel Sheet for Door: Nominal 0.064 inch, 16 gage, factory

primed.
8. Latch and Lock: Cam latch, screwdriver operated.

2.2 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A879/A879M, with cold-rolled steel sheet substrate complying with ASTM A1008/A1008M, Commercial Steel (CS), exposed.

C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with minimum G60 or A60 metallic coating.

D. Frame Anchors: Same material as door face.

E. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M.

2.3 FABRICATION

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.

B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.

1. For concealed flanges with drywall bead, provide edge trim for gypsum panels securely attached to perimeter of frames.
2. For concealed flanges with plaster bead for full-bed plaster applications, provide zinc-coated expanded-metal lath and exposed casing bead welded to perimeter of frames.

D. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling. Provide access sleeves for each latch operator and install in holes cut through finish.

1. For recessed doors with plaster infill, provide self-furring expanded-metal lath attached to door panel.

E. Latch and Lock Hardware:

1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.

2.4 FINISHES

A. Comply with NAAMM/NOMMA AMP 500 for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF ACCESS DOORS AND FRAMES

A. Comply with manufacturer's written instructions for installing access doors and frames.

3.3 FIELD QUALITY CONTROL

A. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

B. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

3.4 ADJUSTING

A. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION 08 31 13

SECTION 083416 – HYDRAULIC HANGAR DOORS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Custom designed single-panel hydraulic doors.

1.2 RELATED SECTIONS

A. Section 05 50 00 - Metal Fabrications. Door opening jamb and head members.

B. Section 06 10 00 - Rough Carpentry. Door opening jamb and head members.

C. Section 07 20 00 - Thermal Protection.

D. Section 08 70 00 - Hardware.

E. Section 09 70 00 - Wall Finishes.

F. Section 09 91 23 - Interior Painting. Field painting.

G. Division 16 - Electrical wiring and conduit, fuses, disconnect switches, connection of operator to power supply, installation of control station and wiring, and connection to alarm system.

H. Section 13 34 19 “Metal Building Systems" for pre-engineered metal building system.

1.3 REFERENCES

A. ASTM International (ASTM):
   1. ASTM A36 - Standard Specification for Carbon Structural Steel.
   2. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

B. American Society of Civil Engineers (ASCE):
   1. ASCE 7 - Minimum Design Loads for Buildings and Other Structures.

C. American Welding Society (AWS).

D. Hydraulics Institute (HI).

E. International Building Code (IBC).

F. National Electric Code (NEC),

G. National Fire Protection Association (NFPA).

1.4 SUBMITTALS

A. Submit under provisions of Section 01 33 00 – Submittal Procedures.

B. Product Data:
   1. Manufacturer's data sheets on each product to be used.
   2. Preparation instructions and recommendations.
   3. Storage and handling requirements and recommendations.
   4. Typical installation methods.
   5. Include construction details, material descriptions, dimensions of individual components, and finishes.
   6. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
   7. Include description of automatic-closing device and testing and resetting instructions.

C. Shop Drawings: Include details of materials, construction, and finish. Include relationship with adjacent construction. For each installation and for special components not dimensioned or detailed in manufacturer's product data.
   1. Include plans, elevations, sections, and mounting details as details of the door's connection to the building.
   2. Include details of equipment assemblies, and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
   4. For exterior components, include details of provisions for assembly expansion and contraction and for excluding and draining moisture to the exterior.
   5. Show locations of controls, locking devices, and other accessories.
   6. Include diagrams for power, signal, and control wiring, include.

D. Delegated-Design: For systems indicated by a Registered Professional Engineer, Certified and Licensed in the state or municipality the project is located.
   1. Details of fabrication of components.
   2. Signed and sealed design calculations for systems indicated used to determine load carrying capacities.
   3. Analysis Data: Signed and sealed.
   4. Sizing Methods and Calculations: Signed and sealed.

1.5 CLOSEOUT SUBMITTAL

A. Maintenance Data: Submit operation and maintenance manuals for systems that provide basic data relating to the design, operation, and maintenance of the door and its related systems.

B. The electrical distribution system

C. Provide basic data relating to the design, operation, and maintenance of

D. The electrical distribution system

E. The door manufacturer will submit maintenance manuals to the owners.

F. Manufacturer's warranty

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with a minimum five years documented experience.

B. Installer Qualifications: Company specializing in performing Work of this section with minimum five years documented experience with projects of similar scope and complexity.

C. Source Limitations: Provide each type of product from a single manufacturing source to ensure uniformity.

1.7 DELEGATED DESIGN

A. Engage a qualified professional engineer, as defined in Section 01 40 00 - Quality Requirements.
   1. Must be licensed in State or Municipality the project is located.
   2. Comply with performance requirements and design criteria.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store and handle in strict compliance with manufacturer's written instructions and recommendations.

B. Protect from damage due to weather, excessive temperature, and construction operations.

1.9 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

1.10 WARRANTY

A. Manufacturer's standard limited warranty including seven (7) year warranty on materials and workmanship of the door structure and three (3) year warranty on electrical and hydraulic components.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Power Lift Hydraulic Doors
   2. Schweiss Doors
   3. Well Built Industries

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. The Custom hydraulic door design is to comply with relevant IBC, NEC, and NFPA standards and relevant local codes governed by authorities having jurisdiction at the

Project location. Where standards and local codes differ, the stricter is to apply.

B. Typical Hydraulic Door Reaction Design Parameters:
   1. Wind Load:
      a. Wind Speed: Per the drawings
      b. Wind Exposure: C.
      c. Risk Category: II.
   2. Door Final Clear Opening Size: 90 ft wide by 26 ft tall.
   3. Door Manufacturer to provide specific door reaction design parameters including all anticipated cladding and insulation upon award of contract.

2.3 HYDRAULIC DOORS

A. Basis of Design: Hydraulic Door as designed and furnished by a licensed manufacturer.
   1. Construction of Panel and Frame Sections:
      a. Framing:
         1) Structural Steel Tubing: ASTM A500 minimum.
         2) Structural Steel Flats, Bars, and Angles: ASTM A36 minimum.
         3) Hinge Pins: ASTM 1144 Stress Proof or AISI 4140 Heat Treated.
      b. Frames: Structural steel tubing and other structural steel shapes.
         1) Design to same loading requirements for live, dead and wind loads as the surrounding construction.
         2) Maximum Spacing:
            a) Between Vertical Members: 96 inches (2438 mm).
            b) Between Horizontal Members: 48 inches (1219 mm).
      c. Panel Frame: Factory-welded at all joints and connections, with smooth welds minimum 1/4 inch (6 mm) thick.
      d. Frame and Panel System: Swinging door leaf panel mounted to manufactured door frame.
         1) Door Leaf Panel: Not to be mounted directly to building header.
      e. Cane Bolts: Cane bolts (2) at inside of bottom door truss at equal spacing.

         1) If Severe or Abnormal Weather is Anticipated: Cane bolts are to engage by lowering bolt into a hole in the floor slab. This will aid in preventing building or door damage.
         2) Normal Weather Conditions: Cane bolt may be left in the raised disengaged position.
         3) Never operate door when cane bolts are in the lower engaged position.
   2. Hinges: Silent, greaseless, efficient, with zero maintenance.
      a. Permanent Bronze Bushings: Teflon impregnated providing a greaseless solution to hinge lubrication.
      b. Hinge Pin: Yield Strength: 100,000 psi (689475.7 kPa).
   3. Factory-Supplied Upper Weather Stripping: Shipped with frame and door panel for field-install.
   4. Factory-Supplied Lower Weather Stripping: Installed on door panel before installation.
   5. Hydraulic Doors: Operated by hydraulic cylinders mechanically fastened to

swinging door leaf and manufacturer's door frame.

6. Two Hydraulic Cylinders: open and close hydraulic door. Designed to carry required loads during operation, open position, and closed position.
   a. Internal Stops: Installed to prevent over-extension of cylinders, restricting system from opening or closing beyond its limits.
   b. Equipped with restrictors to control oil flow on the down cycle.
7. System to Lock Closed: Hydraulic cylinders to provide a minimum of 1,000 lbf of total closing force.
8. Electric over hydraulic locks on cylinder ports:
   a. Normally closed hydraulic valve opens when power unit momentary switch is pressed, closes when momentary switch is released.
9. Hydraulic Power Unit:
   a. Power: 15 HP.
      1) 460 VAC 3-Phase: Requires 50 Amp breaker.
      2) Double Push Button Controls:
         a) Push button for desired direction according to labels; raise or lower.
         b) Buttons require constant pressure to operate.
         c) When pressure on button is released, pump operation stops causing door to stop and stay at door's present position.
   b. Power: 20 HP.
      1) 460 AC 3-Phase: Requires 70 Amp breaker.
      2) Double Push Button Controls:
         a) Push button for desired direction according to labels; raise or lower.
         b) Buttons require constant pressure to operate.
         c) When pressure on button is released, pump operation stops causing door to stop and stay at door's present position.
   c. Electric motor and pump are combined into one self-contained unit located adjacent to the door.
      1) Fastened to Framing: Four, 1/4 inch (6 mm) lags.
   d. The Owner is responsible for providing electrical power connections for the pump unit.
   e. Electrical power installation is to meet federal, state, and local codes.
   f. Pre-wired and factory tested. Final hook-up by others.
   g. Controls: Wired for constant-hold operation to raise or lower the door.
      1) Controls Height: 72 inches (1829 mm) or higher from finished floor. Reference drawings for control location.
   h. Hydraulic Oil: ISO 32 or ISO 22.

B. Finishes:
   1. System Frames and Panels: Cleaned and painted with direct to metal paint, prepared for field finish.
   2. Exterior Field Finish: By others. Door Manufacturer is to approve finishing and application.
   3. Interior Field Finish: By others. Door Manufacturer is to approve finishing and application.

C. Available Accessories and Options:
   1. Secondary Bottom Door Seal: Foam core seal for climate-controlled facilities.

2. Warning horn with strobe light assembly at exterior side of door.

D. Sensors stop the door from continuing in the direction of a detected obstruction but allows door travel in the reverse direction of the obstruction. Sensors interrupt current to the solenoid coils that shift the hydraulic directional control valve to raise or lower the door in order to stop the door. They do not stop the motor on the power unit, they stop oil flow to the cylinders in the direction of travel of the obstruction.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly constructed and prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect in writing of unsatisfactory preparation before proceeding.

C. Building rough opening jambs and header to be plumb and level within 1/4 inch (13 mm) from end to end.

D. Foundation below door to be level and flat within 1/2 inch (13 mm) variation across door opening.

E. Examine locations of electrical connections.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. No materials of any kind may protrude from building surface between manufacturer door frame and building structure (jambs, header).

3.3 INSTALLATION

A. Install hangar doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified, approved submittals, and in proper relationship with adjacent construction.
   1. Installation of custom designed hydraulic door completed by licensed door manufacturer personnel only.
   2. Steel Rough Opening: Door frame stitch welded to building jamb and header.
   3. Install doors controls at the mounting locations indicated per the drawings.

3.4 FIELD QUALITY CONTROL

A. Field Inspection: Coordinate field inspection in accordance with appropriate sections in Division 01.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections and to furnish reports to Architect.

C. Perform the following tests and inspections:
   1. Test door release, closing, and alarm operations. Test manual operation of door. Reset door-closing mechanism after successful test.

D. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

E. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

F. Manufacturer's Services: Coordinate manufacturer's services in accordance with appropriate sections in Division 01.

3.5 STARTUP SERVICE

A. Engage an authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. After electrical circuitry has been energized, operate doors to confirm proper motor rotation and door performance.
   3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

3.6 ADJUSTING

A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.

B. Lubricate parts as recommended by manufacturer.

C. Adjust seals to provide tight fit around entire perimeter.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hangar doors and to adjust and operate .

3.8 CLEANING AND PROTECTION

A. Clean products in accordance with the manufacturer's recommendations.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 08 36 13 - SECTIONAL DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sectional-door assemblies.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for miscellaneous steel supports.

1.2 ACTION SUBMITTALS

A. Product Data: For each type and size of sectional door and accessory.

1. Include construction details, material descriptions, dimensions of individual components, profile door sections, and finishes.
2. For power-operated doors, include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.

B. Shop Drawings: For each installation and for components not dimensioned or detailed in manufacturer's product data.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
4. Include diagrams for power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified, in manufacturer's standard size.

D. Samples for Initial Selection: For units with factory-applied finishes.

1. Include Samples of accessories involving color selection.

E. Samples for Verification: For each type of exposed finish and for each color and texture required on the following components, in manufacturer's standard sizes:

1. Translucent panel.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Sample Warranties: For manufacturer's warranty and finish warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sectional doors to include in maintenance manuals.

B. Manufacturer's warranty.

C. Finish warranty.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of sectional doors that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including, but not limited to, excessive deflection.
b. Faulty operation of hardware.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use; rust through.
d. Delamination of exterior or interior facing materials.

2. Warranty Period: Five years from date of Substantial Completion.

B. Finish Warranty: Manufacturer agrees to repair or replace components that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain sectional doors from single source from single manufacturer.

1. Obtain operators and controls from sectional door manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Provide sectional doors that comply with performance requirements specified without failure from defective manufacture, fabrication, installation, or other defects in construction.

B. Structural Performance, Exterior Doors: Capable of withstanding the design wind loads.

1. Design Wind Load: Uniform pressure (velocity pressure) of 20 lbf/sq. ft., acting inward and outward.
2. Testing: In accordance with ASTM E330/E330M or DASMA 108 for garage doors and complying with DASMA 108 acceptance criteria.
3. Deflection Limits: Design sectional doors to withstand design wind loads without evidencing permanent deformation or disengagement of door components.

    a. Deflection of door sections in horizontal position (open) shall not exceed 1/120 of door width.
    b. Deflection of horizontal track assembly shall not exceed 1/240 of door height.

4. Operability under Wind Load: Design sectional doors to remain operable under uniform pressure (velocity pressure) of 30 lbf/sq. ft. wind load, acting inward and outward.

2.3 SECTIONAL-DOOR ASSEMBLY

A. Sectional Door: Provide aluminum sectional door formed with hinged sections and fabricated so that finished door assembly is rigid and aligned with tight hairline joints; free of warp, twist, and deformation; and complies with requirements in DASMA 102.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Overhead Door 521S or comparable product by one of the following:

    a. Raynor Garage Doors
    b. Windsor Door

B. Operation Cycles: Door components and operators capable of operating for not less than 25,000 operation cycles. One operation cycle is complete when door is opened from closed position to the open position and returned to closed position.

C. Air Infiltration: Maximum rate of 0.4 cfm/sq. ft. not more than indicated when tested in accordance with ASTM E283 or DASMA 105.

1. Air Infiltration: Maximum rate of 0.08 cfm/sq.ft. at 15 and 25 mph.

D. U-Value: 0.130 Btu/sq. ft. x h x deg F.

E. Aluminum Sections: ASTM B221 extruded-aluminum stile and rail members of alloy and temper standard with manufacturer for type of use and finish indicated; in minimum

thickness required to comply with requirements; with rail and stile dimensions and profiles indicated on Drawings; and with overlapped or interlocked weather- and pinch-resistant seal at meeting rails.

1. Door-Section Thickness: 1-3/4 inches.
2. Section Reinforcing: Continuous horizontal and diagonal reinforcement as required to stiffen door and for wind loading. Ensure that reinforcement does not obstruct vision lites.

    a. Hardware Locations: Provide reinforcement for hardware attachment.

3. Insulated Stiles and Rails: Fill stiles and rails manufacturer's standard polyurethane expanding foam.
4. Glazed Panels: Manufacturer's standard, aluminum-framed section with glazing sealed with glazing tape and aluminum glazing bead. Glazing as follows:
5. Solid Aluminum Panels: ASTM B209, alloy and temper standard with manufacturer for use and finish for bottom section of door.

    a. Description: 1/2-inch- thick overall insulated panel composed of 0.050-inch aluminum interior and exterior panels with an extruded polystyrene (EPS) core.
    b. Attachment to Frame: Sealed with glazing tape and aluminum glazing bead.
    c. Aluminum Surface: Smooth.

F. Track: Manufacturer's standard, galvanized-steel, vertical-lift track system. Provide complete system including brackets, bracing, and reinforcement to ensure rigid support of ball-bearing roller guides.

1. Material: Galvanized steel, ASTM A653/A653M, minimum G60 zinc coating.
2. Size: As recommended in writing by manufacturer for door size, weight, track configuration and door clearances indicated on Drawings.
3. Track Reinforcement and Supports: Provide galvanized-steel members to support track without sag, sway, and vibration during opening and closing of doors. Slot vertical sections of track spaced 2 inches apart for door-drop safety device.

    a. Vertical Track: Incline vertical track to ensure weathertight closure at jambs. Provide continuous angle attached to track and wall.
    b. Horizontal Track: Provide continuous reinforcing angle from curve in track to end of track, attached to track and supported at points by laterally braced attachments to overhead structural members.

G. Weatherseals: Replaceable, adjustable, continuous, compressible weather-stripping gaskets of flexible vinyl, rubber, or neoprene fitted to bottom top jambs of door. Provide combination bottom weatherseal and sensor edge for bottom seal.

H. Windows: Manufacturer's standard window units of shape and size and in locations indicated on Drawings. Set glazing in vinyl, rubber, or neoprene glazing channel. Provide removable stops of same material as door-section frames. Provide the following glazing:

1. Clear Polycarbonate Plastic: 3 mm thick, transparent, fire-retardant, UV-resistant, polycarbonate sheet manufactured by extrusion process.

I. Hardware: Heavy-duty, corrosion-resistant hardware, with hot-dip galvanized, stainless steel, or other corrosion-resistant fasteners, to suit door type.

1. Hinges: Heavy-duty, galvanized-steel hinges of not less than 0.079-inch nominal coated thickness at each end stile and at each intermediate stile, in accordance with manufacturer's written recommendations for door size.

a. Attach hinges to door sections through stiles and rails with bolts and lock nuts or lock washers and nuts. Use rivets or self-tapping fasteners where access to nuts is impossible.
b. Provide double-end hinges where required for doors more than 16 ft. wide unless otherwise recommended by door manufacturer in writing.

2. Rollers: Heavy-duty rollers with steel ball bearings in case-hardened steel races, mounted to suit slope of track. Extend roller shaft through both hinges where double hinges are required. Match roller-tire diameter to track width.

a. Roller-Tire Material: Manufacturer's standard.

J. Counterbalance Mechanism:

1. Torsion Spring: Adjustable-tension torsion springs complying with requirements of DASMA 102 for number of operation cycles indicated, mounted on torsion shaft.
2. Cables: Galvanized-steel, multistrand, lifting cables with cable safety factor of at least 5 to 1.
3. Cable Safety Device: Include a spring-loaded steel or bronze cam mounted to bottom door roller assembly on each side and designed to automatically stop door if lifting cable breaks.
4. Bracket: Provide anchor support bracket as required to connect stationary end of spring to the wall and to level the shaft and prevent sag.

K. Electric Door Operator: Electric door operator assembly of size and capacity recommended by door manufacturer for door and operation cycles specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral gearing for locking door, and accessories required for proper operation.

1. Comply with NFPA 70.
2. Control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6; with NFPA 70, Class 2 control circuit, maximum 24 V ac or dc.
3. Safety: Listed in accordance with UL 325 by a qualified testing agency for commercial or industrial use; moving parts of operator enclosed or guarded if exposed and mounted at 8 ft. or lower.
4. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.
5. Operator Type: Jackshaft, side mounted.
6. Motor: Reversible-type with controller (disconnect switch) for exterior, dusty, wet,

or humid motor exposure. Use adjustable motor-mounting bases for belt-driven operators.

a. Motor Size: As required to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. and not more than 12 in./sec., without exceeding nameplate ratings or service factor.
b. Electrical Characteristics:

1) Phase: Polyphase.
2) Volts: 230 V.

7. Limit Switches: Equip motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.
8. Obstruction Detection: Automatic external entrapment protection consisting of automatic safety sensor capable of protecting full width of door opening. Activation of device immediately stops and reverses downward door travel.

a. Unmonitored Entrapment Protection: Pneumatic sensor edge, black, located within weatherseal mounted to bottom bar.

9. Control Station: Surface mounted, three-position (open, close, and stop) control.

a. Operation: Push button.
b. Interior-Mounted Unit: Full-guarded, surface-mounted, standard-duty, weatherproof-type, NEMA ICS 6, Type 4 enclosure.
c. Features: Provide the following:

1) Radio-control operation.

10. Emergency Manual Operation: Chain type designed so required force for door operation does not exceed 25 lbf.
11. Emergency Operation Disconnect Device: Hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
12. Motor Removal: Design operator so motor can be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.

L. Metal Finish: Comply with NAAMM/NOMMA's "Metal Finishes Manual for Architectural and Metal Products (AMP 500-06)" for recommendations for applying and designating finishes.

1. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

a. Aluminum Finish: Comply with AAMA 2603 requirements for pigmented

organic coatings applied to aluminum extrusions and panels.

b. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install sectional doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; in accordance with manufacturer's written instructions.

B. Tracks:

1. Fasten vertical track assembly to opening jambs and framing with fasteners spaced not more than 24 inches apart.
2. Hang horizontal track assembly from structural overhead framing with angles or channel hangers attached to framing by welding or bolting, or both. Provide sway bracing, diagonal bracing, and reinforcement as required for rigid installation of track and door-operating equipment.

C. Accessibility: Install sectional doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.

D. Power-Operated Doors: Install[**automatic garage doors openers**] in accordance with UL 325.

3.3 STARTUP SERVICES

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.

B. Lubricate bearings and sliding parts as recommended by manufacturer.

C. Adjust doors and seals to provide weather-resistant fit around entire perimeter.

D. Touchup Painting Galvanized Material: Immediately after welding galvanized materials, clean welds and abraded galvanized surfaces and repair galvanizing to comply with ASTM A780/A780M.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain sectional doors.

END OF SECTION 08 36 13

SECTION 08 41 13 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aluminum-framed entrance and storefront systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories.

B. Shop Drawings:

1. Plans, elevations, sections, full-size details, and attachments to other work.
2. Details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
3. Full-size isometric details of each type of vertical-to-horizontal intersection of aluminum-framed entrance and storefront systems, showing the following:

    a. Joinery, including concealed welds.
    b. Anchorage.
    c. Expansion provisions.
    d. Glazing.
    e. Flashing and drainage.

4. Connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
5. Point-to-point wiring diagrams showing the following:

    a. Power requirements for each electrically operated door hardware.
    b. Location and types of switches, signal device, conduit sizes, and number and size of wires.

6. Signed and sealed by the qualified professional engineer responsible for their preparation.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.

D. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures

and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.

1.3 INFORMATIONAL SUBMITTALS

A. Energy Performance Certificates: For aluminum-framed entrance and storefront systems, accessories, and components, from manufacturer.

1. Basis for Certification: NFRC-certified energy performance values for each aluminum-framed entrance and storefront system.

B. Product Test Reports: For aluminum-framed entrance and storefront systems, for tests performed by a qualified testing agency.

C. Preconstruction Test Reports: For aluminum-framed entrance and storefront systems.

1. Test Reports: Prepared by a qualified preconstruction testing agency for each preconstruction test.

D. Source Quality-Control Reports: For aluminum-framed entrance and storefront systems.

E. Qualification Statements:

1. For Installer and field testing agency.

F. Sample Warranties: For aluminum-framed entrance and storefront systems.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For aluminum-framed entrance and storefront systems.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Fabricator of products.
2. Entity that employs installers and supervisors who are trained and approved by manufacturer.
3. Authorized representative who is trained and approved by manufacturer.
4. Entity that is certified under the North American Contractor Certification Program (NACC) and that employs installers and supervisors who are trained and approved by manufacturer and who are certified under the Architectural Glass and Metal Technician (AGMT) certification program.

B. Testing Agency Qualifications: Qualified in accordance with ASTM E699 for testing indicated and acceptable to Owner and Architect.

C. Egress Door Inspector Qualifications:

1. Inspector for field quality-control inspections of egress door assemblies to comply with qualifications set forth in NFPA 101, Ch. 7 "Means of Egress," Section "Means of Egress Components," Article "Inspection of Door Openings."
2. Inspector for field quality-control inspections of egress door assemblies to be certified under DHI's certification program as a Fire and Egress Door Assembly Inspector (FDAI) or a Certified Fire and Egress Door Assembly Inspector (CFDAI).

D. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

1.6 WARRANTY

A. Special Warranty: Installer agrees to repair or replace components of aluminum-framed entrance and storefront systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures, including , but not limited to, excessive deflection.
b. Deterioration of metals and other materials beyond normal weathering.
c. Noise or vibration creation by wind and thermal and structural movements.
d. Water penetration through fixed glazing and framing areas.
e. Failure of operating components.

2. Warranty Period: 10 years from date of Substantial Completion.

B. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D 2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D 4214.
c. Cracking, peeling, or chipping.

2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain all components of aluminum-framed entrance and storefront system, including framing and accessories, from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrance and storefront systems representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Aluminum-framed entrance and storefront systems to withstand movements of supporting structure, including, but not limited to, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
2. Failure also includes the following:

    a. Thermal stresses transferring to building structure.
    b. Glass breakage.
    c. Noise or vibration created by wind and thermal and structural movements.
    d. Loosening or weakening of fasteners, attachments, and other components.
    e. Failure of operating units.

B. Structural Loads:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: As indicated on Drawings.

C. Deflection of Framing Members Supporting Glass: At design wind load, as follows:

1. Deflection Normal to Wall Plane: Limited to 1/175 of length of span of the framing member for lengths of up to 13 feet 6 inches and to 1/240 of length of span of the framing member plus 1/4 inch for lengths greater than 13 feet 6 inches.
2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch.

    a. Operable Units: Provide a minimum 1/16-inch clearance between framing members and operable units.

3. Cantilever Deflection - Limited to 2L/175 at unsupported cantilevers.

D. Structural: Test in accordance with ASTM E330/E330M as follows:

1. When tested at positive and negative wind-load design pressures, storefront assemblies, including entrance doors, do not evidence deflection exceeding specified limits.

2. When tested at 150 percent of positive and negative wind-load design pressures, storefront assemblies, including entrance doors and anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

E. Water Penetration under Static Pressure: Test in accordance with ASTM E331 as follows:

1. No evidence of water penetration through fixed glazing and framing areas, including entrance doors, when tested in accordance with a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft..

F. Water Penetration under Dynamic Pressure: Test in accordance with AAMA 501.1 as follows:

1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft..
2. Maximum Water Leakage: No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.

G. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:

1. Thermal Transmittance (U-factor):

a. Fixed Glazing and Framing Areas: U-factor for the system of not more than 0.41 Btu/sq. ft. x h x deg F as determined in accordance with NFRC 100.
b. Entrance Doors: U-factor of not more than 0.68 Btu/sq. ft. x h x deg F as determined in accordance with NFRC 100.

2. Solar Heat-Gain Coefficient (SHGC):

a. Fixed Glazing and Framing Areas: SHGC for the system of not more than 0.35 as determined in accordance with NFRC 200.
b. Entrance Doors: SHGC of not more than 0.40 as determined in accordance with NFRC 200.

3. Air Leakage:

a. Fixed Glazing and Framing Areas: Air leakage for the system of not more than [**0.06 cfm/sq. ft.**]<**Insert value**> at a static-air-pressure differential of 1.57 lbf/sq. ft. when tested in accordance with ASTM E283.
b. Entrance Doors: Air leakage of not more than 1.0 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..

4. Condensation Resistance Factor (CRF):

    a. Fixed Glazing and Framing Areas: CRF for the system of not less than 55 as determined in accordance with AAMA 1503.
    b. Entrance Doors: CRF of not less than 63 as determined in accordance with AAMA 1503.

H. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested in accordance with AAMA 501.5.

    a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F.
    b. Low Exterior Ambient-Air Temperature: 0 deg F.
    c. Interior Ambient-Air Temperature: 75 deg F.

I. Structural-Sealant Joints:

1. Designed to carry gravity loads of glazing.

J. Structural Sealant: ASTM C1184. Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed, aluminum-framed entrance and storefront systems without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant to occur before adhesive failure.

1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate, because sealant-to-substrate bond strength exceeds sealant's internal strength.

2.3 ALUMINUM-FRAMED ENTRANCE AND STOREFRONT SYSTEMS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. EFCO Corporation
2. Kawneer Company, Inc.; Arconic Corporation
3. OldCastle BuildingEnvelope (OBE)
4. Tubelite Inc.

B. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.

1. Exterior Framing Construction: Thermally broken.

2. Interior Vestibule Framing Construction: Nonthermal.
3. Glazing System: Retained mechanically with gaskets on four sides.
4. Glazing Plane: Front.
5. Finish: Clear anodic finish.
6. Fabrication Method: Field-fabricated stick system.
7. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
8. Steel Reinforcement: As required by manufacturer.

C. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.

D. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

E. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing or automatic operation.

1. Door Construction: 1-3/4-inch overall thickness, with minimum 0.125-inch- thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.

    a. Thermal Construction: High-performance plastic connectors separate aluminum members exposed to the exterior from members exposed to the interior.

2. Door Design: Wide stile; 5-inch nominal width.
3. Glazing Stops and Gaskets: Square, snap-on, extruded-aluminum stops and preformed gaskets.

    a. Provide nonremovable glazing stops on outside of door.

4. Finish: Match adjacent storefront framing finish.

2.4 ENTRANCE DOOR HARDWARE

A. Entrance Door Hardware: Hardware not specified in this Section is specified in Section 087100 "Door Hardware."

B. General: Provide entrance door hardware and entrance door hardware sets indicated in "Entrance Door Hardware Sets" Article for each entrance door, to comply with requirements in this Section.

1. Entrance Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and products complying with BHMA standard referenced.
2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
3. Opening-Force Requirements:

a. Egress Doors: Not more than 15 lbf to release the latch and not more than 30 lbf to set the door in motion and not more than 15 lbf to open the door to its minimum required width.
b. Accessible Interior Doors: Not more than 5 lbf to fully open door.

C. Continuous-Gear Hinges: BHMA A156.26.

D. Panic Exit Devices: BHMA A156.3, Grade 1, listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing in accordance with UL 305.

E. Cylinders:

1. As specified in Section 087100 "Door Hardware."
2. BHMA A156.5, Grade 1.

a. Keying: Master key system. Permanently inscribe each key with a visual key control number and include notation "DO NOT DUPLICATE" to be furnished by Owner.

F. Strikes: Provide strike with black-plastic dust box for each latch or lock bolt; fabricated for aluminum framing.

G. Operating Trim: BHMA A156.6.

H. Closers: BHMA A156.4, Grade 1, with accessories required for a complete installation, sized as required by door size, exposure to weather, and anticipated frequency of use; adjustable to comply with field conditions and requirements for opening force.

I. Concealed Overhead Holders and Stops: BHMA A156.8, Grade 1.

J. Door Stops: BHMA A156.16, Grade 1, floor or wall mounted, as appropriate for door location indicated, with integral rubber bumper.

K. Weather Stripping: Manufacturer's standard replaceable components.

1. Compression Type: Made of ASTM D2000 molded neoprene or ASTM D2287 molded PVC.
2. Sliding Type: AAMA 701/702, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.

L. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.

M. Thresholds: BHMA A156.21 raised thresholds beveled with a slope of not more than 1:2, with maximum height of 1/2 inch.

2.5 GLAZING

A. Glazing: Comply with Section 088000 "Glazing."

B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.

2.6 MATERIALS

A. Sheet and Plate: ASTM B209.

B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221.

C. Structural Profiles: ASTM B308/B308M.

D. Steel Reinforcement:

1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.

E. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods in accordance with recommendations in SSPC-SP COM, and prepare surfaces in accordance with applicable SSPC standard.

2.7 ACCESSORIES

A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
2. Reinforce members as required to receive fastener threads.

B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.

1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A123/A123M or ASTM A153/A153M requirements.

C. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.

D. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for 30-mil thickness per coat.

E. Rigid PVC filler.

2.8 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Physical and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Provisions for field replacement of glazing from interior.
6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

E. Storefront Framing: Fabricate components for assembly using screw-spline system.

F. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.

1. At interior and exterior doors, provide compression weather stripping at fixed stops.

G. Entrance Doors: Reinforce doors as required for installing entrance door hardware.

1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
2. At exterior doors, provide weather sweeps applied to door bottoms.

H. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.

I. After fabrication, clearly mark components to identify their locations in Project in accordance with Shop Drawings.

2.9 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF ALUMINUM-FRAMED ENTRANCE AND STOREFRONT SYSTEMS

A. Comply with manufacturer's written instructions.

B. Do not install damaged components.

C. Fit joints to produce hairline joints free of burrs and distortion.

D. Rigidly secure nonmovement joints.

E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.

F. Seal perimeter and other joints watertight unless otherwise indicated.

G. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

H. Set continuous sill members and flashing in full sealant bed, as specified in Section 079200 "Joint Sealants," to produce weathertight installation.

I. Install joint filler behind sealant as recommended by sealant manufacturer.

J. Install components plumb and true in alignment with established lines and grades.

K. Install entrance doors to produce smooth operation and tight fit at contact points.

1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware in accordance with entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

L. Install glazing as specified in Section 088000 "Glazing."

3.3 ERECTION TOLERANCES

A. Install aluminum-framed entrance and storefront systems to comply with the following maximum tolerances:

1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
3. Alignment:

    a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
    b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
    c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.

4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests.

B. Tests: Perform the following tests on representative areas of aluminum-framed entrance and storefront systems.

1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect to be tested in accordance with AAMA 501.2 and to not evidence water penetration.

    a. Perform a minimum of two tests in areas as directed by Architect.

2. Air Leakage: ASTM E783 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than 0.09 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..

    a. Perform a minimum of two tests in areas as directed by Architect.

3. Water Penetration: ASTM E1105 at a minimum uniform and cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft., and to not evidence water penetration.

C. Inspection Agency: Engage a qualified inspector to perform inspections.

D. Inspections:

1. Egress Door Inspections: Inspect each aluminum-framed entrance door equipped with panic hardware, located in an exit enclosure, electrically controlled, and equipped with special locking arrangements, in accordance with NFPA 101, Ch. 7 "Means of Egress," Section "Means of Egress Components,"

Article "Inspection of Door Openings."

E. Aluminum-framed entrance and storefront systems will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.5 MAINTENANCE SERVICE

A. Entrance Door Hardware Maintenance:

1. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of entrance door hardware.
2. Initial Maintenance Service: Beginning at Substantial Completion, provide six months' full maintenance by skilled employees of entrance door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper entrance door hardware operation at rated speed and capacity. Use parts and supplies that are the same as those used in the manufacture and installation of original equipment.

END OF SECTION 08 41 13

SECTION 08 45 23 - FIBERGLASS-SANDWICH-PANEL ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes aluminum-framed assemblies incorporating fiberglass-sandwich panels as follows:

1. Wall assemblies.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for aluminum components of panel assemblies.

B. Shop Drawings: For panel assemblies.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include details of provisions for assembly expansion and contraction and for draining moisture within the assembly to the exterior.

C. Samples: In manufacturer's standard size.

1. For each type of fiberglass-sandwich panel.
2. For each type of exposed finish for framing members.

D. Fabrication Samples: Of each framing system intersection and adjacent panels, made from 12-inch lengths of full-size framing members and showing details of the following:

1. Joinery.
2. Anchorage.
3. Expansion provisions.
4. Fiberglass-sandwich panels.
5. Flashing and drainage.

E. Delegated Design Submittals: For panel assemblies indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer andmanufacturer.

B. Product Test Reports: For each fiberglass-sandwich-panel assembly, for tests performed by a qualified testing agency.

C. Evaluation Reports: For fiberglass-sandwich-panel assemblies from ICC-ES.

D. Field quality-control reports.

E. Sample Warranties: For special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For panel assemblies to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: For fiberglass-sandwich panels, a qualified manufacturer whose facilities, processes, and products are monitored by an independent, accredited quality-control agency for compliance with applicable requirements in ICC-ES AC04 or ICC-ES AC177.

B. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of panel assemblies that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including, but not limited to, excessive deflection.
b. Deterioration of metals and other materials beyond normal weathering.
c. Water leakage.

2. Warranty Period: Five years from date of Substantial Completion.

B. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace fiberglass-sandwich panels that exhibit defects in materials or workmanship within specified warranty period.

1. Defects include, but are not limited to, the following:

a. Fiberbloom.
b. Delamination of coating, if any, from exterior face sheet.
c. Color change exceeding requirements.

d. Delamination of panel face sheets from panel cores.

2. Warranty Period: 10 years from date of Substantial Completion.

C. Special Aluminum-Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering.

1. Failures include, but are not limited to, checking, crazing, peeling, chalking, and fading of finishes.
2. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design fiberglass-sandwich-panel assemblies.

B. Structural Loads: As indicated on Drawings.

C. Deflection Limits:

1. Vertical Panel Assemblies: Limited to 1/120 of clear span for each assembly component.
2. Overhead Panel Assemblies: Limited to 1/180 of clear span for each assembly component.

D. Structural-Test Performance: Provide panel assemblies tested in accordance with ASTM E330, as follows:

1. When tested at positive and negative wind-load design pressures, assemblies do not show evidence of deflection exceeding specified limits.
2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not show evidence of material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

E. Water Penetration under Static Pressure: Provide panel assemblies that do not evidence water penetration through fixed glazing and framing areas when tested in accordance with ASTM E331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft..

F. Water Penetration under Dynamic Pressure: Provide panel assemblies that do not evidence water leakage through fixed glazing and framing areas when tested in accordance with AAMA 501.1 under dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft..

1. Maximum Water Leakage: No uncontrolled water penetrating aluminum-framed systems or water appearing on systems' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water that is controlled by flashing and gutters and drained to the exterior, or water that cannot damage adjacent materials or finishes.

G. Thermal Movements: Allow for thermal movements from ambient- and surface-temperature changes. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

H. Energy Performance: Provide panel assemblies with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:

1. Thermal Transmittance (U-Factor): Fixed glazing and framing areas to have U-factor of not more than 0.80 Btu/sq. ft. x h x deg F as determined in accordance with NFRC 100.
2. Solar Heat Gain Coefficient (SHGC): Fixed glazing and framing areas to have a SHGC of no greater than 0.6 as determined in accordance with NFRC 200.
3. Air Infiltration: Maximum air leakage through fixed glazing and framing areas of 0.30 cfm/sq. ft. of fixed wall area as determined in accordance with ASTM E283 at a minimum static-air-pressure differential of 1.57 lbf/sq. ft..

2.2 FIBERGLASS-SANDWICH-PANEL ASSEMBLIES

A. General: Refer to product indicated on Drawings.

B. Fiberglass-Sandwich-Panel Assemblies: Translucent assemblies that are supported by aluminum framing and glazed with fiberglass-sandwich panels.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Kalwall Corporation
b. Major Industries, Inc.

2.3 FIBERGLASS-SANDWICH PANELS

A. Fiberglass-Sandwich Panels: Uniformly colored, translucent, thermoset, fiberglass-reinforced-polymer face sheets bonded to both sides of a grid core.

B. Panel Thickness: 2-3/4 inches or 4 inches.

C. Grid Core: Mechanically interlocked, extruded-aluminum I-beams, with a minimum flange width of 7/16 inch.

1. Extruded Aluminum: ASTM B221, in alloy and temper recommended in writing by

manufacturer.
2. I-Beam Construction: Thermally broken, extruded aluminum.
3. Grid Pattern: Inline rectangle, nominal 12 by 24 inches.

D. Exterior Face Sheet:

1. Thickness: 0.070 inch.
2. Color: As selected by Architect from manufacturer's full range.
3. Protective Weathering Surface: Manufacturer's standard.

E. Interior Face Sheet:

1. Thickness: 0.045 inch.
2. Color: As selected by Architect from manufacturer's full range.

F. Fiberglass-Sandwich-Panel Adhesive: Manufacturer's standard for permanent adhesion of facings to cores.

G. Panel Strength:

1. Maximum Panel Deflection: 3-1/2 inches when a 4-by-12-foot panel is tested in accordance with ASTM E72 at 34 lbf/sq. ft., with a maximum 0.090-inch set deflection after five minutes.
2. Panel Support Strength: Capable of supporting, without failure, a 300-lbf concentrated load when applied to a 3-inch- diameter disk in accordance with ASTM E661.

H. Panel Performance:

1. Self-Ignition Temperature: 650 deg F or more in accordance with ASTM D1929.
2. Smoke-Developed Index: 450 or less in accordance with ASTM E84, or 75 or less in accordance with ASTM D2843.
3. Combustibility Classification: Class CC1 based on testing in accordance with ASTM D635.
4. Interior Finish Classification: Class A based on testing in accordance with ASTM E84.
5. Color Change: Not more than 3.0 units Delta E, when measured in accordance with ASTM D2244, after outdoor weathering compliant with procedures in ASTM D1435.

    a. Outdoor Weathering Conditions: Sixty months in southern Florida.

6. Impact Resistance: No fracture or tear at impact of 60 ft. x lbf by a 3-1/4-inch-diameter, 5-lb freefalling ball in accordance with UL 972 test procedure.
7. Haze Factor: Greater than 90 percent when tested in accordance with ASTM D1003.

2.4 ALUMINUM FRAMING SYSTEMS

A. Components: Manufacturer's standard extruded-aluminum members of thickness

required and reinforced as required to support imposed loads.

1. Construction: Thermally broken, extruded aluminum.

B. Aluminum: Alloy and temper recommended in writing by manufacturer for type of use and finish indicated.

1. Sheet and Plate: ASTM B209.
2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221.
3. Extruded Structural Pipe and Tubes: ASTM B429/B429M.
4. Structural Profiles: ASTM B308/B308M.

C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning skylight components.

D. Fasteners and Accessories: Manufacturer's standard, corrosion-resistant, nonstaining, and nonbleeding fasteners and accessories; compatible with adjacent materials.

1. At closures, retaining caps, or battens, use ASTM A193/A193M, 300 series stainless steel screws.
2. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
3. At movement joints, use slip-joint linings, spacers, and sleeves of material and type recommended in writing by manufacturer.

E. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A123/A123M orASTM A153/A153Mrequirements.

F. Anchor Bolts: ASTM A307, Grade A, galvanized steel.

G. Concealed Flashing: Corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.

H. Exposed Flashing and Closures: Aluminum sheet not less than 0.040 inch thick, finished to match framing.

I. Framing Gaskets: Manufacturer's standard.

J. Frame-System Sealants: As recommended in writing by manufacturer.

K. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.5 FABRICATION

A. Frame System Fabrication:

1. Fabricate components that, when assembled, have the following characteristics:

a. Profiles that are sharp, straight, and free of defects or deformations.

b. Accurately fitted joints with ends coped or mitered.
c. Internal guttering systems or other means to drain water passing through joints, and moisture migrating within assembly to exterior.

2. Fabricate sill closures with weep holes and for installation as continuous component.
3. Reinforce components as required to receive fastener threads.

B. Panel Fabrication: Factory assemble and seal panels.

1. Laminate face sheets to grid core under a controlled process using heat and pressure to produce straight adhesive bonding lines that cover width of core members and that have sharp edges.

a. White spots indicating lack of bond at intersections of grid-core members are limited in number to four for every 40 sq. ft. of panel and limited in diameter to 3/64 inch.

2. Fabricate with grid pattern that is symmetrical about centerlines of each panel.
3. Fabricate panel to allow condensation within panel to escape.
4. Reinforce panel corners.

2.6 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

B. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

1. Color: As selected by Architect from full range of industry colors and color densities.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Comply with manufacturer's written instructions.

1. Do not install damaged components.
2. Fit joints between aluminum components to produce hairline joints free of burrs and distortion.
3. Rigidly secure nonmovement joints.

4. Install anchors with separators and isolators to prevent metal corrosion, electrolytic deterioration, and immobilization of moving joints.
5. Seal joints watertight unless otherwise indicated.

B. Metal Protection: Where aluminum components will contact dissimilar materials, protect against galvanic action by painting contact surfaces with corrosion-resistant coating or by installing nonconductive spacers as recommended in writing by manufacturer for this purpose.

C. Install components plumb and true in alignment with established lines and elevations.

D. Skylight Assemblies: Install continuous aluminum sill closures with weatherproof expansion joints and locked and sealed corners. Locate weep holes at rafters. Install components to drain water passing through joints and moisture migrating within assembly to exterior.

E. Erection Tolerances: Install panel assemblies to comply with the following maximum tolerances:

1. Alignment: Limit offset from true alignment to 1/32 inch where surfaces abut in line, edge to edge, at corners, or where a reveal or protruding element separates aligned surfaces by less than 3 inches; otherwise, limit offset to 1/8 inch.
2. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet, but no greater than 1/2 inch over total length.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

1. Water-Spray Test: Before installation of interior finishes has begun, panel assemblies to be tested in accordance with AAMA 501.2 and to not show evidence of water penetration.
2. Water Penetration under Static Pressure: Before installation of interior finishes has begun, areas to be tested in accordance with ASTM E1105.

a. Test Procedures: Test under uniform cyclic static-air pressure.
b. Static-Air-Pressure Difference: 0.067 times the pressure specified for laboratory testing according to ASTM E331.
c. Water Penetration: None.

B. Repair or remove work where test results and inspections indicate that it does not comply with specified requirements.

C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

D. Prepare test and inspection reports.

END OF SECTION 08 45 23

SECTION 08 71 00 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hinges.
2. Lock cylinders.
3. Door gasketing.
4. Thresholds.

B. Related Requirements:

1. Section 081113 "Hollow Metal Doors and Frames" for astragals provided as part of labeled fire-rated assemblies.
2. Section 081216 "Aluminum Frames" for door silencers provided as part of aluminum frames.
3. Section 081416 "Flush Wood Doors" for integral intumescent seals provided as part of labeled fire-rated assemblies.
4. Section 102600 "Wall and Door Protection" for plastic door protection units that match wall protection units.
5. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications, apply to this section.

1.2 COORDINATION

A. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

B. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.

C. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Conference participants must include Installer's Architectural Hardware Consultant and Owner's security consultant.

B. Keying Conference: Conduct conference at Project site.

1. Conference participants must include Installer's Architectural Hardware Consultant and Owner's security consultant.
2. Incorporate conference decisions into keying schedule after reviewing door hardware keying system, including, but not limited to, the following:

    a. Flow of traffic and degree of security required.
    b. Preliminary key system schematic diagram.
    c. Requirements for key control system.
    d. Requirements for access control.
    e. Address for delivery of keys.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For electrified door hardware.

1. Include diagrams for power, signal, and control wiring.
2. Include details of interface of electrified door hardware and building safety and security systems.

C. Door Hardware Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant. Coordinate door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Submittal Sequence: Submit door hardware schedule concurrent with submissions of product data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.
2. Format: Use same scheduling sequence and format and use same door numbers as in door hardware schedule in the Contract Documents.
3. Content: Include the following information:

    a. Identification number, location, hand, fire rating, size, and material of each door and frame.
    b. Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
    c. Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
    d. Description of electrified door hardware sequences of operation and interfaces with other building control systems.
    e. Fastenings and other installation information.
    f. Explanation of abbreviations, symbols, and designations contained in door hardware schedule.
    g. Mounting locations for door hardware.

h. List of related door devices specified in other Sections for each door and frame.

D. Keying Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Architectural Hardware Consultant.

B. Product Test Reports: For compliance with accessibility requirements, for tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.

C. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of door hardware to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Architectural Hardware Consultant Qualifications: A person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and who is currently certified by DHI as an Architectural Hardware Consultant (AHC).

1.8 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lockup for door hardware delivered to Project site.

B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.

C. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

D. Deliver keys and permanent cores to Owner by registered mail or overnight package service.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

    a. Structural failures, including excessive deflection, cracking, or breakage.
    b. Faulty operation of doors and door hardware.
    c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period: Three years from date of Substantial Completion unless otherwise indicated below:

    a. Exit Devices: Two years from date of Substantial Completion.
    b. Manual Closers: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of door hardware from single manufacturer.

1. Provide electrified door hardware from same manufacturer as mechanical door hardware unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Door Assemblies: Where fire-rated doors are indicated, provide door hardware complying with NFPA 80 that is listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.

B. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that complies with requirements of assemblies tested in accordance with UL 1784 and installed in compliance with NFPA 105.

1. Air-Leakage Rate: Maximum air leakage of 0.3 cfm per sq. ft. at the tested pressure differential of 0.3 inch wg of water.

C. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

E. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the DOT's "ADA Standards for Transportation Facilities" the ABA standards of the Federal agency having jurisdiction.

1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.
2. Comply with the following maximum opening-force requirements:

    a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf applied perpendicular to door.
    b. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.

3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch high.
4. Adjust door closer sweep periods so that, from an open position of 90 degrees, the door will take at least 5 seconds to move to a position of 12 degrees from the latch.

2.3 HINGES

A. Hinges: ANSI/BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

    a. Allegion plc
    b. McKinney Products Company; ASSA ABLOY Accessories and Door Controls Group, Inc.; ASSA ABLOY

2.4 MECHANICAL LOCKS AND LATCHES

A. Lock Functions: As indicated in door hardware schedule.

B. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:

1. Bored Locks: Minimum 1/2-inch latchbolt throw.
2. Mortise Locks: Minimum 3/4-inch latchbolt throw.

C. Lock Backset: 2-3/4 inches unless otherwise indicated.

D. Lock Trim:

1. Description: As indicated on Drawings.

E. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.

2.5 LOCK CYLINDERS

A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver. Provide cylinder from same manufacturer of locking devices.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Allegion plc
b. Arrow USA; an ASSA ABLOY Group company
c. ASSA, Inc.
d. Corbin Russwin, Inc.; an ASSA ABLOY Group company
e. SARGENT Manufacturing Company; ASSA ABLOY

B. Standard Lock Cylinders: ANSI/BHMA A156.5, Grade 1 permanent cores; face finished to match lockset.

1. Core Type: Removable.

2.6 KEYING

A. Keying System: Factory registered, complying with guidelines in ANSI/BHMA A156.28, appendix. Provide one extra key blank for each lock. Incorporate decisions made in keying conference.

B. Keys: Brass.

1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:

a. Notation: "DO NOT DUPLICATE."

2.7 ACCESSORIES FOR PAIRS OF DOORS

A. Coordinators: ANSI/BHMA A156.3; consisting of active-leaf, hold-open lever, and inactive-leaf release trigger; fabricated from steel with nylon-coated strike plates; with built-in, adjustable safety release; and with internal override.

B. Astragals: ANSI/BHMA A156.22.

2.8 THRESHOLDS

A. Thresholds: ANSI/BHMA A156.21; fabricated to full width of opening indicated.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work

2.9 FABRICATION

A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rating labels and as otherwise approved by Architect.

1. Manufacturer's identification is permitted on rim of lock cylinders only.

B. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and ANSI/BHMA A156.18.

C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended; however, aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware unless otherwise indicated.

1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
2. Fire-Rated Applications:

    a. Wood or Machine Screws: For the following:

        1) Hinges mortised to doors or frames; use threaded-to-the-head wood screws for wood doors and frames.
        2) Strike plates to frames.
        3) Closers to doors and frames.

    b. Steel Through Bolts: For the following unless door blocking is provided:

        1) Surface hinges to doors.
        2) Closers to doors and frames.
        3) Surface-mounted exit devices.

3. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
4. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.10 FINISHES

A. Provide finishes complying with ANSI/BHMA A156.18 as indicated in door hardware schedule.

B. Protect mechanical finishes on exposed surfaces from damage by applying a

strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Steel Doors and Frames: For surface-applied door hardware, drill and tap doors and frames in accordance with ANSI/SDI A250.6.

B. Wood Doors: Comply with door and hardware manufacturers' written instructions.

3.3 INSTALLATION OF DOOR HARDWARE

A. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.

1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
2. Wood Doors: DHI's "Recommended Locations for Architectural Hardware for Wood Flush Doors."

B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

C. Hinges: Install types and in quantities indicated in door hardware schedule, but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches of door height, whichever is more stringent, unless other

equivalent means of support for door, such as spring hinges or pivots, are provided.

D. Lock Cylinders: Install construction cores to secure building and areas during construction period.

1. Replace construction cores with permanent cores as indicated in keying schedule ordirected by Owner.
2. Furnish permanent cores to Owner for installation.

E. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 079200 "Joint Sealants."

F. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.

G. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

H. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

I. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.4 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

B. Occupancy Adjustment: Approximately three months after date of Substantial Completion, Installer's Architectural Hardware Consultant is to examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.5 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain door hardware.

HARDWARE SET: 1
DOOR NUMBER:
101-A 102-A
EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	Door Handles	RM4255 48 12HD	US32D	RM
2	EA	Continuous Hinge	112XY EPT	711	IVE
2	EA	Power Transfer	EPT10 CON	622	VON
1	EA	Elec Panic Hardware	RX-LC-QEL-9847-EO-CON 24 VDC	622/711	VON
1	EA	Elec Panic Hardware	RX-LC-QEL-9847-NL-CON 24 VDC	622/711	VON
1	EA	Rim Housing	20-079	622/711	SCH
1	EA	FSIC Perm. Core	23-030 EV29 T	622/711	SCH
1	EA	FSIC Constr. Core	23-030 ICX	ORG	SCH
1	EA	Concealed Closer	2030 HBMP	693	LCN
1	EA	Kick Plate	8400 10" X 2" LDW B-CS	622	IVE
2	EA	Wire Harness	CON X LENGTH REQ'D		SCH
1	EA	Door Contact	679-05 HM/WD As Req'd	BLK	SCE
1	EA	Power Supply	By Security System Integrator		B/O
1	EA	Card Reader	By Security System Integrator		
1	EA	Wiring Diagram	By Security System Integrator		
1	EA	Gasketing	By Door Manufacturer	BK	KCI
1	EA	Threshold	By Door Manufacturer	A	KCI
1	EA	Sweep	By Door Manufacturer	NB	KCI

HARDWARE SET: 2
DOOR NUMBER:
101-B
EACH TO HAVE:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	Continuous Hinge	112XY	711	IVE
2	EA	Door Handles	RM4255 12HD	US32D	RM
2	EA	Concealed Closer	2030 HBMP	622/711	LCN
2	EA	Kick Plate	8400 10" X 2" LDW B-CS	622	IVE
1	EA	Gasketing	By Door Manufacturer	BK	KCI
1	EA	Threshold	By Door Manufacturer	A	KCI
1	EA	Sweep	By Door Manufacturer	NB	KCI

HARDWARE SET: 3
DOOR NUMBER:
102-B Rated
EACH TO HAVE:

4	EA	Hinge	5BB1HW	652	IVE
1	EA	Entry Lock	ND50P6 RHO	626	SCH
1	EA	FSIC Perm. Core	23-030 EV29 T	630	SCH
1	EA	Surface Closer	4040XP RW/PA	689	LCN
1	EA	Kick Plate	8400 10" X 2" LDW B-CS	630	IVE
1	EA	Gasketing	488SBK PSA	BK	ZER
1	EA	Door Sweep	355 PL NH	AA	ZER

HARDWARE SET: 4
DOOR NUMBER:
103-A
EACH TO HAVE:

4	EA	Hinge	5BB1HW	652	IVE
1	EA	Storeroom Lock	ND80P6 RHO	626	SCH
1	EA	FSIC Perm. Core	23-030 EV29 T	630	SCH
1	EA	Surface Closer	4040XP RW/PA	689	LCN
1	EA	Kick Plate	8400 10" X 2" LDW B-CS	630	IVE
1	EA	Gasketing	488SBK PSA	BK	ZER
1	EA	Door Sweep	355 PL NH	AA	ZER
1	EA	Threshold	103A-223	A	ZER

HARDWARE SET: 5 – POSSIBLY COMBINE WITH SET 6
DOOR NUMBER:
100-D 100-F 100-C
EACH TO HAVE:

1	EA	Cont. Hinge	112XY EPT	628	IVE
1	EA	Power Transfer	EPT10 CON	689	VON
1	EA	Elec Panic Hardware	RX-LC-QEL-9847-NL-CON 24 VDC	630	VON
1	EA	FSIC Perm. Core	23-030 EV29 T	630	SCH
1	EA	FSIC Constr. Core	23-030 ICX	ORG	SCH
1	EA	Surface Closer	4040XP RW/PA	689	LCN
1	EA	Kick Plate	8400 10" X 2" LDW B-CS	630	IVE
1	EA	Gasketing	488SBK PSA	BK	ZER
1	EA	Door Sweep	355 PL NH	AA	ZER
1	EA	Threshold	103A-223	A	ZER
2	EA	Wire Harness	CON X LENGTH REQ'D		SCH
1	EA	Door Contact	679-05 HM/WD As Req'd	BLK	SCE
1	EA	Power Supply	By Security System Integrator		B/O
1	EA	Card Reader	By Security System Integrator		
1	EA	Wiring Diagram	By Security System Integrator		

HARDWARE SET: 6
DOOR NUMBER:
001-A Gate
EACH TO HAVE:

1	EA	Entry Push-Button Lock	CO100CY50KPP6 RHO	626	SCH
1	EA	Elec Panic Hardware	9852-EO w/ weep	630	VON
1	EA	FSIC Perm. Core	23-030 EV29 T	630	SCH
1	EA	Keedex Gate Box	K-BXRHO-8155		KED
		Spring Hinge	Provided By Gate Manufacturer		
		Hinges	Provided By Gate Manufacturer		
		Stops	Provided By Gate Manufacturer		

HARDWARE SET: 7
DOOR NUMBER:
104-A 108-A 202-A
EACH TO HAVE:

3	EA	Hinge	5BB1HW	652	IVE
1	EA	Classroom Lock	ND70P6 RHO	626	SCH
1	EA	FSIC Perm. Core	23-030 EV29 T	630	SCH
1	EA	Kick Plate	8400 10" X 2" LDW B-CS	630	IVE
1	EA	Wall Stop	WS406/407CCV	630	IVE
3	EA	Silencer	SR64	GRY	IVE

HARDWARE SET: 8
DOOR NUMBER:
105-A Rated
EACH TO HAVE:

4	EA	Hinge	5BB1HW	652	IVE
1	EA	Classroom Lock	ND70P6 RHO	626	SCH
1	EA	FSIC Perm. Core	23-030 EV29 T	630	SCH
1	EA	Surface Closer	4040XP RW/PA	689	LCN
1	EA	Kick Plate	8400 10" X 2" LDW B-CS	630	IVE
1	EA	Gasketing	488SBK PSA	BK	ZER
1	EA	Door Sweep	355 PL NH	AA	ZER
1	EA	Kick Plate	8400 10" X 2" LDW B-CS	630	IVE

HARDWARE SET: 9
DOOR NUMBER:
201-A Rated
EACH TO HAVE:

3	EA	Hinge	5BB1HW	652	IVE
1	EA	Hinge	5BB1HW TW8M	652	IVE
1	EA	Card Reader Lock	ND80P6EU RHO RX CON 12/24V DC	626	SCH
1	EA	FSIC Perm. Core	23-030 EV29 T	630	SCH
1	EA	Surface Closer	4040XP RW/PA	689	LCN
1	EA	Kick Plate	8400 10" X 2" LDW B-CS	630	IVE
1	EA	Gasketing	488SBK PSA	BK	ZER
1	EA	Door Sweep	355 PL NH	AA	ZER
1	EA	Wire Harness	CON X LENGTH REQ'D		SCH
1	EA	Door Contact	679-05 HM/WD As Req'd	BLK	SCE
1	EA	Power Supply	By Security System Integrator		B/O
1	EA	Card Reader	By Security System Integrator		

SECTION 08 80 00 - GLAZING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glass products.
2. Laminated glass.
3. Miscellaneous glazing materials.

B. Related Requirements:

1. Section 088813 "Fire-Rated Glazing."

1.2 DEFINITIONS

A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters in accordance with ASTM C1036.

C. IBC: International Building Code.

D. Interspace: Space between lites of an insulating-glass unit.

1.3 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances to achieve proper safety margins for glazing retention under each design load case, load case combination, and service condition.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review temporary protection requirements for glazing during and after installation.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches square.

C. Glazing Accessory Samples: For sealants, in 12-inch lengths.[**Install sealant Samples between two strips of material representative in color of adjoining framing system.**]

D. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer andmanufacturers of fabricated glass units.

B. Product Certificates: For glass.

C. Product Test Reports: For fabricated glass and glazing sealants, for tests performed by a qualified testing agency.

1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.

D. Preconstruction adhesion and compatibility test report.

E. Sample Warranties: For special warranties.

1.7 QUALITY ASSURANCE

A. Fabricated-Glass Manufacturer Qualifications: A qualified manufacturer of fabricated glass units who is approved by primary glass manufacturer.

B. Installer Qualifications: A qualified glazing contractor for this Project who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal (AG&M) contractors and who employs glazing technicians certified under the Architectural Glass and Metal Technician (AGMT) certification program.

C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.

D. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021 to conduct the testing indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials in accordance with manufacturer's written instructions.

Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F.

1.10 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.

1. Warranty Period: 10 years from date of Substantial Completion.

B. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is obstruction of vision by dust, moisture, or film on interior surfaces of glass.

1. Warranty Period: 10 years from date of Substantial Completion.

C. Manufacturer's Special Warranty for Heat-Soaked Tempered Glass: Manufacturer agrees to replace heat-soaked tempered glass units that spontaneously break due to nickel sulfide (NiS) inclusions at a rate exceeding 0.3 percent (3/1000) within specified warranty period. Coverage for any other cause is excluded.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Source Limitations for Glass: Obtain and coated glass from single source from single manufacturer.

B. Source Limitations for Glazing Accessories: For each product and installation method, obtain from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined in accordance with the IBC and ASTM E1300:

1. Design Wind Pressures: As indicated on Drawings.

    a. Wind Design Data: As indicated on Drawings.

2. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch, whichever is less.
3. Thermal Loads: Design glazing to resist thermal stress breakage induced by differential temperature conditions and limited air circulation within individual glass lites and insulated glazing units.

C. Windborne-Debris-Impact Resistance: Exterior glazing shall pass ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone 4 for basic protection.

1. Large-Missile Test: For glazing located within 30 feet of grade.
2. Small-Missile Test: For glazing located between 30 feet and 60 feet above grade.

D. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

E. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:

1. For monolithic-glass lites, properties are based on units with lites of thickness indicated.
2. For insulating-glass units, properties are based on units of thickness indicated for

overall unit and for each lite.

3. U-Factors: Center-of-glazing values, in accordance with NFRC 100 and based on most current non-beta version of LBL's WINDOW computer program, expressed as Btu/sq. ft. x h x deg F.
4. SHGC and Visible Transmittance: Center-of-glazing values, in accordance with NFRC 200 and based on most current non-beta version of LBL's WINDOW computer program.
5. Visible Reflectance: Center-of-glazing values, in accordance with NFRC 300.

2.3 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. NGA Publications: "Glazing Manual."
2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than thickness indicated.

1. Minimum Glass Thickness for Exterior Lites: 6 mm.
2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.

D. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.4 GLASS PRODUCTS

A. Clear Annealed Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. AGC Glass Company North America, Inc.
b. Cardinal Glass Industries, Inc.

c. Guardian Glass LLC
d. Pilkington North America; NSG Group
e. Saint-Gobain Glass Corp
f. Vitro Architectural Glass

B. Tinted Annealed Float Glass: ASTM C1036, Type I, Class 2 (tinted), Quality-Q3.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. AGC Glass Company North America, Inc.
b. Guardian Glass LLC
c. Pilkington North America; NSG Group
d. Saint-Gobain Glass Corp
e. Vitro Architectural Glass

C. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

D. Heat-Strengthened Float Glass: ASTM C1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

E. Reflective- and Low-E-Coated Vision Glass: ASTM C1376.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Cardinal Glass Industries, Inc.
b. Guardian Glass LLC
c. Pilkington North America; NSG Group
d. Saint-Gobain Glass Corp
e. Vitro Architectural Glass

2.5 INSULATING GLASS

A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified in accordance with ASTM E2190.

1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.

2. Desiccant: Molecular sieve or silica gel, or a blend of both.

2.6 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, recommended in writing by manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks:

1. EPDM orSilicone with Shore A durometer hardness of 85, plus or minus 5.
2. Type recommended in writing by sealant or glass manufacturer.

D. Spacers:

1. Neoprene blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
2. Type recommended in writing by sealant or glass manufacturer.

E. Edge Blocks:

1. EPDM orSilicone with Shore A durometer hardness per manufacturer's written instructions.
2. Type recommended in writing by sealant or glass manufacturer.

F. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

2.7 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.

a. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.

C. Grind smooth and polish exposed glass edges and corners.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Presence and functioning of weep systems.
3. Minimum required face and edge clearances.
4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

F. Provide spacers for glass lites where length plus width is larger than 50 inches.

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances,

unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.

2. Provide 1/8-inch- minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and in accordance with requirements in referenced glazing publications.

H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

J. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended in writing by gasket manufacturer.

3.4 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.5 CLEANING AND PROTECTION

A. Immediately after installation, remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.

1. If, despite such protection, contaminating substances do contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

C. Remove and replace glass that is damaged during construction period.

D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.6 MONOLITHIC GLASS SCHEDULE

A. Clear Glass Type .: Fully tempered float glass.

1. Minimum Thickness: 12 mm.
2. Safety glazing required.

3.7 INSULATING GLASS SCHEDULE

A. Low-E-Coated, Tinted Insulating Glass Type <.>:

1. Basis-of-Design Product: Solarban 60 Solargray.
2. Overall Unit Thickness: 1 inch.
3. Minimum Thickness of Each Glass Lite: 6 mm.
4. Outdoor Lite: Tinted annealed (Fully Tempered when required) float glass.
5. Tint Color: Gray.
6. Interspace Content: Argon.
7. Indoor Lite: Clear annealed (Fully Tempered when required) float glass.
8. Low-E Coating: Sputtered on second surface.
9. Winter Nighttime U-Factor: 0.29 maximum.
10. Summer Daytime U-Factor: 0.27 maximum.
11. Visible Light Transmittance: 70 percent minimum.
12. SHGC: 0.45 maximum.
13. Safety glazing required.

END OF SECTION 08 80 00

SECTION 08 88 13 - FIRE-RATED GLAZING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire-resistance-rated glazing.

1.2 DEFINITIONS

A. Fire-Resistance-Rated Glazing: Glazing that prevents spread of fire and smoke and radiant heat and complies with requirements for rated walls and rated openings; capable of blocking radiant heat

B. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

C. Glass Thicknesses: Indicated by thickness designations in millimeters in accordance with ASTM C1036.

1.3 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Glass Samples: For each type of glass product; 12 inches square.

C. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and glass testing agency.

B. Product Certificates: For each type of glass and glazing product.

C. Sample Warranties: For special warranties.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the NGA's Certified Glass Installer Program.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials in accordance with manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install fire-resistant glazing until spaces are enclosed and weathertight and temporary HVAC system is operating and maintaining ambient temperature conditions at occupancy levels during remainder of construction period.

1.9 WARRANTY

A. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1. Warranty Period: Five years from date of Substantial Completion.

B. Manufacturer's Special Warranty for Tempered Glazing Units with Clear Intumescent Interlayer: Manufacturer agrees to replace units that deteriorate within specified warranty period. Deterioration of tempered glazing units with clear intumenscent interlayer is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning glass contrary to manufacturer's written instructions. Evidence of failure is air bubbles within units, or obstruction of vision by contamination or deterioration of intumescent interlayer.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Glass: For each glass type, obtain from single source from single manufacturer.

B. Glazing Accessories: For each product and installation method, obtain from single

source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and impact loads (where applicable) without failure, including loss or glass breakage attributable to defective manufacture, fabrication, or installation; deterioration of glazing materials; or other defects in construction.

2.3 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organization below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. NGA Publications: "Laminated Glazing Reference Manual" and"Glazing Manual."

B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or manufacturer. Label shall indicate manufacturer's name, type of glass, glass thickness, and safety glazing standard with which glass complies.

2.4 GLASS PRODUCTS

A. Laminated Glass: ASTM C1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

1. Construction: Laminate glass with polyvinyl butyral interlayer unless fire-protection or fire-resistance rating is based on another product.
2. Interlayer Thickness: Provide thickness as needed to comply with requirements.
3. Interlayer Color: Clear unless otherwise indicated.

2.5 FIRE-RESISTANCE-RATED GLAZING

A. General: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-resistance ratings indicated, based on testing in accordance with ASTM E119 or UL 263.

B. Fire-Resistance-Rated Glazing Labeling: Permanently mark fire-resistance-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, test standard, that glazing is approved for use in walls, and fire-resistance rating in minutes.

C. Fire-Resistance-Rated Framing and Doors: Fire-resistance-rated glazing with 60-, 90-, and 120-minute ratings requires framing and doors from glass supplier, tested as an assembly complying with ASTM E119 or UL 263.

D. Fire-Resistance-Rated Laminated Glass with Intumescent Interlayers: Laminated glass made from multiple plies of uncoated, clear float glass; with intumescent interlayers; complying with 16 CFR 1201, Category II.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. McGrory Glass, Inc
b. Pilkington North America; NSG Group
c. Vetrotech Saint-Gobain

E. Fire-Resistance-Rated Tempered Glazing Units with Clear Intumescent Interlayer: Glazing units made from two or more lites of uncoated, fully tempered, clear float glass; with a perimeter edge seal enclosing a cavity filled with optically clear, intumescent polymer; complying with 16 CFR 1201, Category II.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. SAFTI FIRST Fire Rated Glazing Solutions

2.6 GLAZING ACCESSORIES

A. Provide glazing gaskets, glazing sealants, glazing tapes, setting blocks, spacers, edge blocks, and other glazing accessories that are compatible with glazing products and each other and are approved by testing agencies that listed and labeled fire-resistant glazing products with which products are used for applications and fire-protection ratings indicated.

B. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C1281 and AAMA 800 for products indicated below:

1. AAMA 804.3 tape, where indicated.
2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

C. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:

1. AAMA 810.1, Type 1, for glazing applications in which tape acts as primary sealant.
2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.7 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, recommended in writing by manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

C. Perimeter Insulation for Fire-Resistance-Rated Glazing: Product that is approved by testing agency that listed and labeled fire-resistant glazing product with which it is used for application and fire-protection rating indicated.

2.8 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing, glazing channels, and stops, with Installer present, for compliance with manufacturing and installation tolerances, including those for size, squareness, and offsets at corners, and for compliance with minimum required face and edge clearances.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate fire side and protected side. Label or mark units as needed so that fire side and protected side are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 GLAZING, GENERAL

A. Use methods approved by testing agencies that listed and labeled fire-resistant glazing products.

B. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials unless more stringent requirements are indicated, including those in referenced glazing publications.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass lites where length plus width is larger than 50 inches.

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
2. Provide 1/8-inch- minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and in accordance with requirements in referenced glazing publications.

I. Set glass lites with proper orientation so that coatings face fire side or protected side as specified.

J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended in writing by gasket manufacturer.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until right before each glazing unit is installed.

F. Apply heel bead of elastomeric sealant.

G. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop, so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

D. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 CLEANING AND PROTECTION

A. Immediately after installation, remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.

1. If, despite such protection, contaminating substances do contact with glass, remove substances immediately as recommended in writing by glass manufacturer.

C. Remove and replace glass that is damaged during construction period.

D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION 08 88 13

SECTION 09 22 16 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Nonstructural steel framing.
2. Grid suspension systems.

B. Related Requirements:

1. Section 054000 "Cold-Formed Metal Framing" for exterior and interior loadbearing, structural framing.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include layout, spacings, sizes, thicknesses, and types of nonstructural steel framing and fastening and anchorage details.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, and attachments to adjoining work.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For code-compliance certification of studs and track.

B. Evaluation Reports: From an agency acceptable to authorities having jurisdiction orICC-ES showing compliance with Project requirements, for the following:

1. Studs and track.
2. High-strength steel studs and track.
3. Equivalent corrosion-resistant coating on steel framing.
4. Firestop track.
5. Post-installed anchors.
6. Power-actuated fasteners.

1.4 QUALITY ASSURANCE

A. Code-Compliance Certification of Studs and Track: Provide documentation that framing members are certified in accordance with product-certification program of the Steel Framing Industry Association the Steel Stud Manufacturers Association or the

Supreme Steel Framing System Association.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

B. Protect materials from corrosion, deformation, and other damage during delivery, storage, and handling in accordance with AISI S202.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: Where indicated on Drawings, provide assemblies incorporating nonstructural steel framing identical to those of assemblies tested for fire resistance in accordance with ASTM E119 by an independent testing agency.

B. STC-Rated Assemblies: Where indicated on Drawings, provide assemblies incorporating nonstructural framing identical to those of assemblies tested in accordance with ASTM E90 and classified in accordance with ASTM E413 by an independent testing agency.

C. Horizontal Deflection: For composite wall assemblies, limited to 1/240 of the wall height based on the following horizontal loading:

1. Horizontal Loading: As indicated on Drawings5 lbf/sq. ft..

2.2 NONSTRUCTURAL STEEL FRAMING

A. Framing Members, General: Comply with requirements in AISI S220 for conditions indicated on Drawings.

1. Protective Coating: ASTM A653/A653M, G40 or coating with demonstrated equivalent corrosion resistance. Galvannealed products are unacceptable.

a. Equivalent Corrosion-Resistant Coating: Evaluation report acceptable to authorities having jurisdiction demonstrates corrosion resistance equivalent to specified protective coating.

B. Studs and Track: Conventional members, roll-formed into standard shapes without surface deformations to stiffen framing members.

1. Minimum Base-Steel Thickness: As required by performance requirements for horizontal deflection.
2. Depth: As indicated on Drawings.

C. High-Strength Steel Studs and Track: Roll-formed into proprietary shapes incorporating

ribs, embossment, knurling, or dimensional changes to stiffen framing members.

1. Minimum Base-Steel Thickness and Yield Strength: As required by horizontal deflection performance requirements.
2. Depth: As indicated on Drawings.

D. Slip-Type Head Joints: Where indicated on Drawings, provide[**one of**] the following:

E. Firestop Track: Top track manufactured to allow partition heads to expand and contract with movement of structure above while maintaining continuity of fire-resistance-rated assembly indicated on Drawings; in base-steel thickness not less than that of studs and in width to accommodate depth of studs.

F. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated on Drawings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**CEMCO; California Expanded Metal Products Co.**]
    b. [**ClarkDietrich**]
    c. [**Jaimes Industries, Inc.**]
    d. [**Marino\WARE**]
    e. [**MBA Building Supplies**]
    f. [**MRI Steel Framing, LLC**]
    g. [**Phillips Manufacturing Co**]
    h. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
    i. [**Steel Construction Systems; Stone Group of Companies**]
    j. [**Steel Network, Inc. (The)**]
    k. [**TELLING Industries**]
    l. [**The Mill Steel Co**]
    m. [**US Frame Factory**]
    n. <**Insert manufacturer's name**>

2. Minimum Base-Steel Thickness: [**As indicated on Drawings**][**0.0179 inch**][**0.0269 inch**][**0.0296 inch**][**0.0329 inch**]<**Insert thickness**>.

G. Rigid Hat-Shaped Furring Channels:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

    a. [**CEMCO; California Expanded Metal Products Co.**]
    b. [**ClarkDietrich**]
    c. [**CRACO Mfg., Inc.**]
    d. [**Jaimes Industries, Inc.**]

e. [**Marino\WARE**]
f. [**MBA Building Supplies**]
g. [**MBA Metal Framing**]
h. [**MRI Steel Framing, LLC**]
i. [**Phillips Manufacturing Co**]
j. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
k. [**Steel Construction Systems; Stone Group of Companies**]
l. [**Steel Network, Inc. (The)**]
m. [**TELLING Industries**]
n. [**The Mill Steel Co**]
o. [**UMS Metal Building Systems USA LLC**]
p. [**US Frame Factory**]
q. <**Insert manufacturer's name**>

2. Minimum Base-Steel Thickness: [**As indicated on Drawings**][**0.0179 inch**][**0.0296 inch**][**0.0329 inch**]<**Insert thickness**>.
3. Depth: [**As indicated on Drawings**][**7/8 inch**][**1-1/2 inches**]<**Insert requirements**>.

H. Resilient Furring Channels: 1/2-inch- deep, steel sheet members designed to reduce sound transmission.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. [**CEMCO; California Expanded Metal Products Co.**]
b. [**ClarkDietrich**]
c. [**CRACO Mfg., Inc.**]
d. [**Jaimes Industries, Inc.**]
e. [**Marino\WARE**]
f. [**MBA Building Supplies**]
g. [**MRI Steel Framing, LLC**]
h. [**Phillips Manufacturing Co**]
i. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
j. [**Steel Construction Systems; Stone Group of Companies**]
k. [**Steel Network, Inc. (The)**]
l. [**TELLING Industries**]
m. [**The Mill Steel Co**]
n. [**US Frame Factory**]
o. <**Insert manufacturer's name**>

2. Configuration: [**Asymmetrical**][**or**][**hat shaped**].

I. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 3/4 inch, minimum base-steel thickness of 0.0179 inch, and depth required to fit insulation thickness indicated on Drawings.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available**

manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. [**CEMCO; California Expanded Metal Products Co.**]
b. [**ClarkDietrich**]
c. [**CRACO Mfg., Inc.**]
d. [**Jaimes Industries, Inc.**]
e. [**Marino\WARE**]
f. [**MBA Building Supplies**]
g. [**MBA Metal Framing**]
h. [**MRI Steel Framing, LLC**]
i. [**Phillips Manufacturing Co**]
j. [**SCAFCO Steel Stud Company; Stone Group of Companies**]
k. [**Steel Construction Systems; Stone Group of Companies**]
l. [**Steel Network, Inc. (The)**]
m. [**TELLING Industries**]
n. [**The Mill Steel Co**]
o. [**US Frame Factory**]
p. <**Insert manufacturer's name**>

2.3 GRID SUSPENSION SYSTEMS

A. Grid Suspension Systems for Gypsum Board Ceilings: ASTM C645, direct-hung system composed of main beams and cross-furring members that interlock.

2.4 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.

1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.

C. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.162 inch in diameter.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, substrates, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.

1. Furnish concrete inserts and other devices required to other trades for installation in advance of time needed for coordination and construction.

3.3 INSTALLATION OF NONSTRUCTURAL METAL FRAMING, GENERAL

A. Installation Standard: ASTM C754.

1. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.

B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.

C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

D. Install bracing at terminations in assemblies.

E. Do not bridge building control and expansion joints with framing members. Frame both sides of joints independently.

3.4 INSTALLATION OF NONSTRUCTURAL STEEL FRAMING

A. Install framing system components at spacings indicated on Drawings, but not greater than spacings required by referenced installation standards for assembly types.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install track at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated on Drawings to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.

a. Install two studs at each jamb unless otherwise indicated on Drawings.

b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure unless otherwise indicated on Drawings.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated on Drawings. Install framing below sills of openings to match framing required above door heads.
4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated on Drawings and support closures to make partitions continuous from floor to underside of solid structure.

a. Firestop Track: Install to maintain continuity of fire-resistance-rated assembly indicated on Drawings.

5. STC-Rated Partitions: Install framing to comply with STC-rated assembly indicated on Drawings.
6. Curved Partitions:

a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of at least two studs at ends of arcs, place studs 6 inches o.c.

E. Direct Furring:

1. Screw to wood framing.
2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.

F. Wall-Furring Bracket Systems: Install brackets with serrated edges facing upward spaced at minimum 48 inches o.c. vertically with 6 inches maximum from floor and ceiling, and minimum 36 inches o.c. horizontally with 4 inches maximum from abutting construction, unless otherwise indicated on Drawings.

G. Z-Shaped Furring Members:

1. Erect insulation, specified in Section 072100 "Thermal Insulation," vertically and hold in place with Z-shaped furring members spaced 24 inches o.c.
2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.

H. Suspended Assemblies: Isolate suspension assemblies from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed

by structural movement.

1. Hangers: Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system spaced as indicated on Drawings.

    a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
    b. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.

        1) Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.

    c. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
    d. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
    e. Do not attach hangers to steel roof deck.
    f. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
    g. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
    h. Do not connect or suspend framing from ducts, pipes, or conduit.

2. Carrying Channels (Main Runners): U-channels spaced as indicated on Drawings.
3. Furring Channels (Furring Members): As indicated on Drawings.

    a. Spacing: As indicated on Drawings.
    b. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

I. Installation Tolerances for Nonstructural Steel Framing:

1. Framing Members: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.
2. Suspended Assemblies: Install suspension systems that are level to within 1/8 inch in 12 ft. measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

3.5 INSTALLATION OF GRID SUSPENSION SYSTEMS

A. Grid Suspension Systems: Install in accordance with manufacturer's written instructions. Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

B. Installation Tolerances for Grid Suspension Systems: Install suspension systems that are level to within 1/8 inch in 12 ft. measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 09 22 16

SECTION 09 29 00 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Tile backing panels.
3. Trim accessories.

B. Related Requirements:

1. Section 061600 "Sheathing" for gypsum sheathing for exterior walls.
2. Section 079219 "Acoustical Joint Sealants" for acoustical joint sealants installed in gypsum board assemblies.
3. Section 092216 "Non-Structural Metal Framing" for nonstructural steel framing and suspension systems that support gypsum board panels.
4. Section 093013 "Ceramic Tiling" for cementitious backer units installed as substrates for ceramic tile.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Locations and installation of control and expansion joints, including plans, elevations, sections, and attachment details.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.4 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C840 requirements or manufacturer's written instructions, whichever are more stringent.

B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, moisture damaged, or mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of gypsum panel and joint finishing material from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings in accordance with ASTM E119; tested by a qualified testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings in accordance with ASTM E90 and classified in accordance with ASTM E413; tested by a qualified testing agency.

2.3 GYPSUM BOARD, GENERAL

A. Size: Provide panel products in maximum lengths and widths available that will minimize joints in each area and that correspond with support system specified or indicated on Drawings.

2.4 INTERIOR GYPSUM BOARD

A. Gypsum Wallboard: ASTM C1396/C1396M.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. American Gypsum
    b. Georgia-Pacific Gypsum LLC
    c. USG Corporation

2. Thickness: 5/8".
3. Long Edges: Tapered.

B. Gypsum Board, Type X: ASTM C1396/C1396M.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. American Gypsum
    b. Georgia-Pacific Gypsum LLC
    c. USG Corporation

2. Thickness: 5/8 inch.
3. Long Edges: Tapered.

2.5 TILE BACKING PANELS

A. Glass-Mat, Water-Resistant Backing Board: ASTM C1178/C1178M, with manufacturer's standard edges.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. CertainTeed; SAINT-GOBAIN
    b. Georgia-Pacific Gypsum LLC
    c. USG Corporation

2. Core: 5/8 inch, Type X.
3. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.

B. Cementitious Backer Units: ANSI A118.9 and ASTM C1288 or ASTM C1325, with manufacturer's standard edges.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. James Hardie Building Products, Inc.
    b. PermaBASE Building Products, LLC provided by National Gypsum Company
    c. USG Corporation

2. Thickness: 5/8 inch.
3. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.

C. Water-Resistant Gypsum Backing Board: ASTM C1396/C1396M, with manufacturer's standard edges.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. American Gypsum
b. CertainTeed; SAINT-GOBAIN
c. USG Corporation

2. Core: 5/8 inch, Type X.

2.6 TRIM ACCESSORIES

A. Interior Trim: ASTM C1047.

1. Material: Galvanized-steel sheet or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet.
2. Shapes:

a. Cornerbead.
b. LC-Bead: J-shaped; exposed long flange receives joint compound.
c. L-Bead: L-shaped; exposed long flange receives joint compound.
d. U-Bead: J-shaped; exposed short flange does not receive joint compound.

B. Exterior Trim: ASTM C1047.

1. Material: Hot-dip galvanized-steel sheet, plastic, or rolled zinc.
2. Shapes:

a. Cornerbead.
b. LC-Bead: J-shaped; exposed long flange receives joint compound.
c. Expansion (Control) Joint: One-piece, rolled zinc with V-shaped slot and removable strip covering slot opening.

C. Aluminum Trim: Extruded accessories of profiles and dimensions indicated on Drawings.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Fry Reglet Corporation
b. Gordon Inc.
c. Insert Manufacturers Name

2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B221, Alloy 6063-T5.
3. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

2.7 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C475/C475M requirements.

B. Joint Tape:

1. Interior Gypsum Board: Paper.
2. Exterior Gypsum Soffit Board: Paper.
3. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
4. Tile Backing Panels: As recommended in writing by panel manufacturer.

C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.

    a. Use setting-type compound for installing paper-faced metal trim accessories.

3. Fill Coat: For second coat, use setting-type, sandable topping compound.
4. Finish Coat: For third coat, use setting-type, sandable topping compound.
5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound.

D. Joint Compound for Exterior Applications:

1. Exterior Gypsum Soffit Board: Use setting-type taping compound and setting-type, sandable topping compound.
2. Glass-Mat Gypsum Sheathing Board: As recommended in writing by sheathing board manufacturer.

E. Joint Compound for Tile Backing Panels:

1. Glass-Mat, Water-Resistant Backing Panel: As recommended in writing by backing panel manufacturer.
2. Cementitious Backer Units: As recommended in writing by backer unit manufacturer.
3. Water-Resistant Gypsum Backing Board: Use setting-type taping compound and setting-type, sandable topping compound.

2.8 AUXILIARY MATERIALS

A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.

B. Laminating Adhesive: Adhesive or joint compound recommended in writing by manufacturer for directly adhering gypsum panels to continuous substrate.

C. Steel Drill Screws: ASTM C1002 unless otherwise specified or indicated on Drawings.

1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
2. For fastening cementitious backer units, use screws of type and size

recommended in writing by panel manufacturer.

D. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers as follows:

1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

E. Acoustical Sealant: As specified in Section 079219 "Acoustical Joint Sealants."

F. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."

2.9 TEXTURE FINISHES

A. Primer: As recommended in writing by textured finish manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION AND FINISHING OF PANELS, GENERAL

A. Comply with ASTM C840 requirements.

B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.

D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

E. Form control and expansion joints with space between edges of adjoining gypsum

panels.

F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
2. Fit gypsum panels around ducts, pipes, and conduits.
3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.

G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

I. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C919 requirements and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

J. Install sound-attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 INSTALLATION OF INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:

1. Gypsum Wallboard: As indicated on Drawings.
2. Gypsum Board, Type X: As indicated on Drawings.
3. Glass-Mat Interior Gypsum Board: As indicated on Drawings.

B. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated on Drawings.
2. On partitions/walls, apply gypsum panels vertically (parallel to framing) unless otherwise specified or indicated on Drawings or required by fire-resistance-rated assembly, and minimize end joints.

a. Stagger abutting end joints not less than one framing member in alternate courses of panels.

b. At stairwells and other high walls, install panels horizontally unless otherwise indicated on Drawings or required by fire-resistance-rated assembly.

3. On Z-shaped furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

C. Multilayer Application:

1. On Z-shaped furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
2. Fastening Methods: Fasten base layers with screws; fasten face layers with adhesive and supplementary fasteners.

3.4 INSTALLATION OF TILE BACKING PANELS

A. Glass-Mat, Water-Resistant Backing Panels: Comply with manufacturer's written installation instructions and install at locations indicated to receive tile. Install with 1/4-inch gap where panels abut other construction or penetrations.

3.5 INSTALLATION OF TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim in accordance with manufacturer's written instructions.

B. Control Joints: Install control joints in accordance with ASTM C840 and in specific locations approved by Architect for visual effect.

C. Interior Trim: Install in the following locations:

1. Cornerbead: Install at outside corners.
2. LC-Bead: Install at exposed panel edges.
3. U-Bead: Install at exposed panel edges.
4. Curved-Edge Cornerbead: Install at curved openings.

3.6 APPLICATION OF JOINT TREATMENT MATERIALS

A. Finishing Panel Products: Treat joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare panel surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints and damaged surface areas.

C. Apply joint tape over panel joints, except for trim products specifically indicated as not

intended to receive tape.

D. Interior Gypsum Board: Finish panels to levels indicated below and in accordance with ASTM C840:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 2: Panels that are substrate for tile.
3. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.

    a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."

E. Exterior Gypsum Board for Ceilings and Soffits: Finish in accordance with manufacturer's written instructions.

F. Glass-Mat Faced Panels: Finish in accordance with manufacturer's written instructions.

G. Cementitious Backer Units: Finish in accordance with manufacturer's written instructions.

3.7 APPLICATION OF TEXTURE FINISHES

A. Surface Preparation and Primer: Prepare and apply primer to gypsum panels and other surfaces receiving texture finishes. Apply primer to surfaces that are clean, dry, and smooth.

B. Texture Finish Application: Mix and apply finish using powered spray equipment, to produce a uniform texture free of starved spots or other evidence of thin application or of application patterns.

C. Prevent texture finishes from contacting surfaces not indicated to receive texture finish by covering them with masking agents, polyethylene film, or other means. If, despite these precautions, texture finishes contact these surfaces, immediately remove droppings and overspray to prevent damage in accordance with texture-finish manufacturer's written instructions.

3.8 PROTECTION

A. Protect adjacent surfaces from joint compound and promptly remove from floors and other non-gypsum board surfaces. Repair surfaces stained, marred, or otherwise damaged during gypsum board installation and finishing.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.

2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 09 29 00

SECTION 09 65 13 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermoplastic-rubber base.
2. Vinyl base.
3. Vinyl molding accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified, not less than 12 inches long.

C. Product Schedule: For resilient base and accessory products.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

1.5 FIELD CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following periods:

1. 48 hours before installation.
2. During installation.
3. 48 hours after installation.

B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.

C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 THERMOPLASTIC-RUBBER BASE

A. General: Refer to product indicated on Drawings.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Johnsonite; a Tarkett company
2. Equal approved by architect.

C. Product Standard: ASTM F1861, Type TP (rubber, thermoplastic).

1. Group: I (solid, homogeneous).
2. Style and Location:

a. Style A, Straight: Per finish schedule.

D. Thickness: 0.375.

E. Height: As indicated on Drawings.

F. Lengths: Coils in manufacturer's standard length.

G. Outside Corners: Job formed.

H. Inside Corners: Job formed.

I. Colors: As indicated on Drawings.

2.2 VINYL BASE

A. General: Refer to product indicated on Drawings.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Johnsonite; a Tarkett company
2. Roppe Corporation; Roppe Holding Company

C. Product Standard: ASTM F1861, Type TV (vinyl, thermoplastic).

1. Group: I (solid, homogeneous).
2. Style and Location:

a. Style B, Cove: Per the finish schedule.

D. Minimum Thickness: 0.125 inch.

E. Height: 4 inches.

F. Lengths: Coils in manufacturer's standard length.

G. Outside Corners: Preformed.

H. Inside Corners: Preformed.

I. Colors and Patterns: As indicated on Drawings.

2.3 VINYL MOLDING ACCESSORY

A. General: Refer to product indicated on Drawings.

B. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Johnsonite; a Tarkett company
2. Roppe Corporation; Roppe Holding Company

C. Description: Vinyl transition strips.

D. Profile and Dimensions: As indicated.

E. Locations: At doorways.

F. Colors and Patterns: As indicated on Drawings.

2.4 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Concrete Substrates for Resilient Stair Accessories: Prepare horizontal surfaces according to ASTM F710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
4. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

    a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
    b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install resilient products until materials are the same temperature as space where they are to be installed.

1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.

E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Preformed Corners: Install preformed corners before installing straight pieces.

H. Job-Formed Corners:

1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.

    a. Form without producing discoloration (whitening) at bends.

2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.

    a. Miter or cope corners to minimize open joints.

3.4 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient accessories.

B. Resilient Stair Accessories:

1. Use stair-tread-nose filler to fill nosing substrates that do not conform to tread contours.
2. Tightly adhere to substrates throughout length of each piece.
3. For treads installed as separate, equal-length units, install to produce a flush joint between units.

C. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.5 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.

B. Perform the following operations immediately after completing resilient-product installation:

1. Remove adhesive and other blemishes from surfaces.
2. Sweep and vacuum horizontal surfaces thoroughly.
3. Damp-mop horizontal surfaces to remove marks and soil.

C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 09 65 13

SECTION 09 67 23 - RESINOUS FLOORING

PART 1 - GENERAL

1.1 SUMMARY

1. Resinous flooring.

B. Related Sections:

1. Section 071800 "Traffic Coatings" for vehicular-traffic-bearing, elastomeric flooring systems.
2. Section 096623 "Resinous Matrix Terrazzo Flooring" for thinset, epoxy-matrix terrazzo.
3. Section 03 30 00 - Cast-in-Place Concrete
4. Section 03 39 00 - Concrete Curing

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include manufacturer's technical data, installation instructions, and recommendations for each resinous flooring component required.

B. Samples: For each resinous floor system required and for each color and texture specified, 6 inches square in size, applied to a rigid backing by Installer for this Project.

C. Samples for Initial Selection: For each type of exposed finish required.

D. Samples for Verification: For each resinous flooring system required and for each color and texture specified, 6 inches square, applied to a rigid backing by Installer for this Project.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Material Certificates: For each resinous flooring component.

C. Material Test Reports: For each resinous flooring system, by a qualified testing agency.

D. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For resinous flooring to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Apply full-thickness mockups on 96-inch- square floor area selected by Architect.

a. Include 96-inch length of integral cove base with inside and outside corner.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring installation.

B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring installation.

C. Close spaces to traffic during resinous flooring installation and for 24 hours after installation unless manufacturer recommends a longer period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Flooring products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Flammability: Self-extinguishing in accordance with ASTM D635.

2.2 RESINOUS FLOORING <**Insert drawing designation**>

A. General - Refer to product indicated on Drawings.

B. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Obtain secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from manufacturer recommended in writing by manufacturer of primary materials.

C. System Characteristics:

1. Color and Pattern: As selected by Architect from manufacturer's full range.
2. Overall System Thickness: As indicated on Drawings.

D. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested in accordance with test methods indicated:

1. Compressive Strength: 7,250 psi minimum in accordance with ASTM C579.
2. Water Absorption: 0.14 g/h - m2 percent maximum in accordance with ASTM C413.
3. Abrasion Resistance: 18 mg loss (CS-17 Wheel, 1000 gm load, 1000 cycles) maximum weight loss in accordance with ASTM D4060.
4. Hardness: 76 at 7 days, Shore D in accordance with ASTM D2240.

2.3 INTEGRAL COVE BASE ACCESSORIES

A. Installation Adhesive: As recommended in writing by accessory manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resinous flooring systems.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare and clean substrates in accordance with resinous flooring manufacturer's written instructions for substrate indicated to ensure adhesion.

B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.

1. Roughen concrete substrates as follows:

a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
b. Comply with requirements in SSPC-SP 13/NACE No. 6, with a Concrete Surface Profile of 3 or greater in accordance with ICRI Technical Guideline No. 310.2R, unless manufacturer's written instructions are more stringent.

2. Repair damaged and deteriorated concrete in accordance with resinous flooring manufacturer's written instructions.
3. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
4. Concrete substrate to have a minimum compressive strength of 3,500 psi (24 MPa) at 28 days and a minimum of 215 psi (1.5 MPa) in tension at time of application.

C. Patching and Filling: Use patching and fill material to fill holes and depressions in substrates in accordance with manufacturer's written instructions.

1. Control Joint Treatment: Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring in accordance with manufacturer's written instructions.

D. Resinous Materials: Mix components and prepare materials in accordance with resinous flooring manufacturer's written instructions.

3.3 INSTALLATION

A. Apply components of resinous flooring system in accordance with manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness specified.

1. Coordinate installation of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
2. Cure resinous flooring components in accordance with manufacturer's written instructions. Prevent contamination during installation and curing processes.
3. Expansion and Isolation Joint Treatment: At substrate expansion and isolation joints, comply with resinous flooring manufacturer's written instructions.

B. Primer: Apply primer over prepared substrate at spreading rate recommended in writing by manufacturer.

C. Reinforcing Membrane: Apply reinforcing membrane to substrate cracks.

D. Grout Coat: Apply grout coat to fill voids in surface of final body coat.

E. Topcoats: Apply topcoats in number indicated for flooring system specified, at spreading rates recommended in writing by manufacturer, and to produce wearing surface specified.

3.4 FIELD QUALITY CONTROL

A. Material Sampling: Owner may, at any time and any number of times during resinous flooring installation, require material samples for testing for compliance with requirements.

1. Owner will engage an independent testing agency to take samples of materials being used. Material samples will be taken, identified, sealed, and certified in presence of Contractor.
2. Testing agency will test samples for compliance with requirements, using applicable referenced testing procedures or, if not referenced, using testing procedures listed in manufacturer's product data.
3. If test results show applied materials do not comply with specified requirements, pay for testing, remove noncomplying materials, prepare surfaces coated with unacceptable materials, and reinstall flooring materials to comply with requirements.

B. Core Sampling: At Owner's direction and at locations designated by Owner, take one core sample per 1000 sq. ft. of resinous flooring, or portion of, to verify thickness. For each sample that fails to comply with requirements, take two additional samples. Repair damage caused by coring. Correct deficiencies in installed flooring as indicated by testing.

3.5 PROTECTION

A. Protect resinous flooring from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.

END OF SECTION 09 67 23

SECTION 09 68 13 - TILE CARPETING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Carpet tile.

B. Related Requirements:

1. Section 096513 "Resilient Base and Accessories" for resilient wall base and accessories installed with carpet tile.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to carpet tile installation including, but not limited to, the following:

a. Review delivery, storage, and handling procedures.
b. Review ambient conditions and ventilation procedures.
c. Review subfloor preparation procedures.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
2. Include manufacturer's written installation recommendations for each type of substrate.

B. Shop Drawings: For carpet tile installation, showing the following:

1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
2. Carpet tile type, color, and dye lot.
3. Type of subfloor.
4. Type of installation.
5. Pattern of installation.
6. Pattern type, location, and direction.
7. Pile direction.
8. Type, color, and location of insets and borders.
9. Type, color, and location of edge, transition, and other accessory strips.

10. Transition details to other flooring materials.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of carpet tile.

1. Include Samples of exposed edge, transition, and other accessory stripping involving color or finish selection.

D. Samples for Verification: Actual sample of finished products for each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.

1. Carpet Tile: Full-size Sample.
2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch- long Samples.

E. Product Schedule: For carpet tile. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.

B. Qualification Statements: For Installer.

C. Sample Warranties: For carpet tile.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For carpet tiles. Include the following:

1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials, from the same production run, to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but no fewer than 10 full-size units.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with CRI 104.

1.9 FIELD CONDITIONS

A. Comply with CRI 104 for temperature, humidity, and ventilation limitations.

B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.

C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended in writing by carpet tile manufacturer.

D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

1.10 WARRANTY

A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.

1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
2. Failures include, but are not limited to, the following:

    a. More than 10 percent loss of face fiber, edge raveling, snags, and runs.
    b. Loss of tuft-bind strength.
    c. Excess static discharge.
    d. Delamination.
    e. Dimensional instability.

3. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILE

A. General: Refer to product indicated on Drawings.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. J&J Flooring Group LLC
2. Mohawk Group
3. Shaw Industries Group, Inc.; Berkshire Hathaway Company

C. Color: As selected by Architect from manufacturer's full range.

D. Fiber Content: As indicated of the product on Drawings.

E. Pile Characteristic: As indicated of the product on Drawings pile.

F. Yarn Twist: **As**.

G. Yarn Count: As indicated of the product on Drawings.

H. Density: **As indicat**.

I. Pile Thickness: As indicated of the product on Drawings for finished carpet tile in accordance with ASTM D6859.

J. Stitches: **As**.

K. Gage: **Insert ends per inch**.

L. Total Weight: **As indicat** for finished carpet tile.

M. Primary Backing/Backcoating: Manufacturer's standard composite materials.

N. Secondary Backing: Manufacturer's standard material.

O. Backing System: As indicated of the product on Drawings.

P. Size: As indicated of the product on Drawings.

Q. Applied Treatments:

1. Soil-Resistance Treatment: Manufacturer's standard treatment.
2. Antimicrobial Treatment: Manufacturer's standard treatment that protects carpet tiles as follows:

a. Antimicrobial Activity: Not less than 2 mm halo of inhibition for gram-positive bacteria, not less than 1 mm halo of inhibition for gram-negative

bacteria, and no fungal growth, in accordance with AATCC 174.

R. Performance Characteristics:

1. Texture Appearance Retention Rating (TARR): Heavy traffic, 3.0 minimum in accordance with ASTM D7330.
2. Tuft Bind: Not less than 18 oz/sqyd in accordance with ASTM D1335.

2.2 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended in writing by carpet tile manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive types to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and that are recommended in writing by carpet tile manufacturer for releasable installation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.

B. Examine carpet tile for type, color, pattern, and potential defects.

C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.

1. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

   a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
   b. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
   c. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Comply with CRI 104 and with carpet tile manufacturer's written installation instructions for preparing substrates.

B. Use trowelable leveling and patching compounds, in accordance with manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.

C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.

D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

A. General: Comply with CRI 104, Section 10, "Carpet Tile," and with carpet tile manufacturer's written installation instructions.

B. Installation Method: As recommended in writing by carpet tile manufacturer.

C. Maintain dye-lot integrity. Do not mix dye lots in same area.

D. Maintain pile-direction patterns indicated on Drawings.

E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended in writing by carpet tile manufacturer.

F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.

H. Install pattern parallel to walls and borders.

I. Access Flooring: Stagger joints of carpet tiles so carpet tile grid is offset from access flooring panel grid. Do not fill seams of access flooring panels with carpet adhesive; keep seams free of adhesive.

3.4 CLEANING AND PROTECTION

A. Perform the following operations immediately after installing carpet tile:

1. Remove excess adhesive and other surface blemishes using cleaner recommended in writing by carpet tile manufacturer.
2. Remove yarns that protrude from carpet tile surface.
3. Vacuum carpet tile using commercial machine with face-beater element.

B. Protect installed carpet tile to comply with CRI 104, Section 13.7.

C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 09 68 13

SECTION 09 91 14 - EXTERIOR PAINTING (MPI STANDARDS)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Surface preparation of substrates and application of the following:

1. Exterior paint systems.

1.2 DEFINITIONS

A. MPI Gloss Level G3: Between 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, in accordance with ASTM D523.

B. MPI Gloss Level G4: Between 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, in accordance with ASTM D523.

C. MPI Gloss Level G5: Between 35 to 70 units at 60 degrees, in accordance with ASTM D523.

D. MPI Gloss Level G6: Between 70 to 85 units at 60 degrees, in accordance with ASTM D523.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
2. Include preparation requirements and application instructions.
3. Indicate VOC content.

B. Samples: For each type of topcoat product.

C. Samples for Verification: For each type of paint system and each color and gloss of topcoat. Submit actual paint drawdowns as specified below for verification Samples.

1. Submit Samples on rigid backing, 8 inches square.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

D. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in applicable exterior painting schedule articles to cross-reference paint systems specified in this Section. Include color designations.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match paint products applied and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint Products: 5 percent, but not less than 1 gal. of each material and color applied.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each paint product from single source from single manufacturer.

2.2 EXTERIOR PAINTS, GENERAL

A. Exterior Paint Systems: Subject to compliance with requirements, available products that may be incorporated into the Work include but are not limited to products listed in applicable exterior painting schedule articles for the paint category indicated.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Benjamin Moore & Co.
b. PPG Paints; PPG Industries, Inc.
c. Pratt & Lambert; a subsidiary of The Sherwin-Williams Company
d. Sherwin-Williams Company (The)

B. MPI Standards: Provide products complying with MPI standards indicated in applicable

exterior painting schedule articles and listed in the "MPI Approved Products List."

C. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

D. Colors: As indicated on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Cementitious Composition Board: 12 percent.
3. Masonry (Clay and CMU): 12 percent.
4. Wood: 15 percent.
5. Portland Cement Plaster (Stucco): 12 percent. Verify that plaster is fully cured.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Steel Substrates: Remove loose rust, loose mill scale, loose shop primer, and other loose foreign matter. Clean using methods recommended in writing by paint manufacturer but not less than the following:

1. SSPC-SP 2.
2. SSPC-SP 3.

E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

3.3 APPLICATION OF EXTERIOR PAINT PRODUCTS

A. Apply paints in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."

1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
4. Paint entire exposed surface of window frames and sashes.
5. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
6. Primers specified in applicable exterior painting schedule articles may be omitted on items that are factory primed or factory finished if compatible with intermediate and topcoat coatings and acceptable to intermediate and topcoat paint manufacturers.

B. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

C. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

D. Painting Fire-Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed to view:

a. Equipment, including panelboards and switch gear.
b. Uninsulated metal piping.
c. Uninsulated plastic piping.
d. Pipe hangers and supports.

e. Metal conduit.
f. Plastic conduit.
g. Tanks that do not have factory-applied final finishes.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written instructions, apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written instructions.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

1. Do not clean equipment with free-draining water and prevent solvents, thinners, cleaners, and other contaminants from entering into waterways, sanitary and storm drain systems, and ground.
2. Dispose of contaminants in accordance with requirements of authorities having jurisdiction.
3. Allow empty paint cans to dry before disposal.
4. Collect waste paint by type and deliver to recycling or collection facility.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 EXTERIOR PAINTING SCHEDULE, METAL SUBSTRATES

A. Galvanized-Metal Substrates:

1. Water-Based Light Industrial Coating System: MPI EXT 5.3J.

a. Prime Coat: Primer, epoxy, anticorrosive, MPI #101.
b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
c. Topcoat: Light industrial coating, exterior, water based, semigloss (MPI

Gloss Level G5), MPI #163.

END OF SECTION 09 91 14

SECTION 09 91 24 - INTERIOR PAINTING (MPI STANDARDS)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Surface preparation of substrates and application of the following:

1. Interior paint systems.

B. Related Requirements:

1. Section 051200 "Structural Steel Framing" for shop priming structural steel substrates.
2. Section 055113 "Metal Pan Stairs" for shop priming metal pan stairs.
3. Section 055213 "Pipe and Tube Railings" for shop priming pipe and tube railings.

1.2 DEFINITIONS

A. MPI Gloss Level G1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, in accordance with ASTM D523.

B. MPI Gloss Level G2: Not more than 10 units at 60 degrees and between 10 to 35 units at 85 degrees, in accordance with ASTM D523.

C. MPI Gloss Level G3: Between 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, in accordance with ASTM D523.

D. MPI Gloss Level G4: Between 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, in accordance with ASTM D523.

E. MPI Gloss Level G5: Between 35 to 70 units at 60 degrees, in accordance with ASTM D523.

F. MPI Gloss Level G6: Between 70 to 85 units at 60 degrees, in accordance with ASTM D523.

G. MPI Gloss Level G7: More than 85 units at 60 degrees, in accordance with ASTM D523.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
2. Indicate VOC content.

B. Samples for Verification: For each type of paint system and in each color and gloss of topcoat. Submit actual paint drawdowns as specified below for verification Samples.

1. Submit Samples on rigid backing, 8 inches square.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

C. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in the Interior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match paint products applied and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint Products: 5 percent, but not less than 1 gal. of each material and color applied.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures of less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each paint product from single source from single manufacturer.

2.2 INTERIOR PAINTS, GENERAL

A. Interior Paint Systems: Subject to compliance with requirements, available products that may be incorporated into the Work include but are not limited to products listed in

the applicable interior painting schedule articles for the paint category indicated.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Benjamin Moore & Co.
    b. PPG Paints; PPG Industries, Inc.
    c. Pratt & Lambert; a subsidiary of The Sherwin-Williams Company
    d. Sherwin-Williams Company (The)

B. MPI Standards: Provide products complying with MPI standards indicated in applicable interior painting schedule articles and listed in the "MPI Approved Products List."

C. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, products must be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

D. Colors: As indicated on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Cementitious Composition Board: 12 percent.
3. Masonry (Clay and CMUs): 12 percent.
4. Gypsum Board: 12 percent. Verify that finishing compound is dry and sanded smooth.

C. Verify suitability of substrates, including surface conditions and compatibility, with finishes and primers. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.

F. Steel Substrates: Remove loose rust, loose mill scale, loose shop primer, and other loose foreign matter. Clean using methods recommended in writing by paint manufacturer but not less than the following:

1. SSPC-SP 2.
2. SSPC-SP 3.

G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

H. Galvanized Metal Substrates: Remove grease and oil residue from galvanized metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

I. Aluminum Substrates: Remove loose surface oxidation.

3.3 APPLICATION OF INTERIOR PAINT PRODUCTS

A. Apply paints in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."

1. Use applicators and techniques suited for paint and substrate indicated.

2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
5. Primers specified in applicable interior painting schedule articles may be omitted on items that are factory primed or factory finished if compatible with intermediate and topcoat coatings and acceptable to intermediate and topcoat paint manufacturers.

B. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

C. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

D. Painting Fire-Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed to view in equipment rooms:

    a. Equipment, including panelboards.
    b. Uninsulated metal piping.
    c. Uninsulated plastic piping.
    d. Pipe hangers and supports.
    e. Metal conduit.
    f. Plastic conduit.
    g. Tanks that do not have factory-applied final finishes.
    h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.

2. Paint the following work where exposed to view in occupied spaces:

    a. Equipment, including panelboards.
    b. Uninsulated metal piping.
    c. Uninsulated plastic piping.
    d. Pipe hangers and supports.
    e. Metal conduit.
    f. Plastic conduit.
    g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
    h. Other items as directed by Architect.

3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE, CONCRETE SUBSTRATES

A. Horizontal (Traffic) Surfaces:

1. Water-Based Concrete Floor Sealer System: MPI INT 3.2G.

a. First Coat: Sealer, water based, for concrete floors, matching topcoat.
b. Topcoat: Sealer, water based, for concrete floors, MPI #99.

3.7 INTERIOR PAINTING SCHEDULE, MASONRY SUBSTRATES

A. CMU Substrates:

1. Latex System: MPI INT 4.2A.

a. Prime Coat: Block filler, latex, interior/exterior, MPI #4.
b. Intermediate Coat: Latex, interior, matching topcoat.
c. Topcoat: Latex, interior, (MPI Gloss Level G3), MPI #52.

3.8 INTERIOR PAINTING SCHEDULE, METAL SUBSTRATES

A. Steel and Iron Substrates:

1. Latex over Shop-Applied Quick-Drying Shop Primer System: MPI INT 5.1X.

   a. Prime Coat: Primer, quick dry, for shop application, MPI #275.
   b. Intermediate Coat: Latex, interior, matching topcoat.
   c. Topcoat: Latex, interior, (MPI Gloss Level G3), MPI #52.

2. High-Performance Architectural Latex System: MPI INT 5.1R.

   a. Prime Coat: Primer, alkyd, quick dry, for metal, MPI #76 andanticorrosive, for metal, MPI #79.
   b. Shop-Applied Prime Coat: Shop primer specified in Section where substrate is specified.
   c. Intermediate Coat: Latex, interior, high-performance architectural, matching topcoat.

3. Water-Based Dry-Fall System: MPI INT 5.1C.

   a. Prime Coat: Primer, alkyd, quick dry, for metal, MPI #76 andanticorrosive, for metal, MPI #79.
   b. Shop-Applied Prime Coat: Primer, quick dry, for shop application, MPI #275.
   c. Topcoat: Dry fall, latex, (MPI Gloss Level G3), MPI #155.

B. Galvanized Metal Substrates:

1. Water-Based Light Industrial Coating System: MPI INT 5.3K.

   a. Prime Coat: Primer, galvanized, water based, MPI #134.
   b. Intermediate Coat: Light industrial coating, interior, water based, matching topcoat.
   c. Topcoat: Light industrial coating, interior, water based, semigloss (MPI Gloss Level G5), MPI #153.

2. Water-Based Dry-Fall System: MPI INT 5.3H.

   a. Prime Coat: Dry fall, water based, for galvanized steel, matching topcoat.
   b. Topcoat: Dry fall, water based, for galvanized steel, flat (MPI Gloss Level G1), MPI #133.

3.9 INTERIOR PAINTING SCHEDULE, GYPSUM-BASED SUBSTRATES

A. Gypsum Board and Plaster Substrates:

1. Latex over Latex Sealer System: MPI INT 9.2A.

   a. Prime Coat: Primer sealer, latex, interior, MPI #50.
   b. Intermediate Coat: Latex, interior, matching topcoat.

c. Topcoat: Latex, interior, (MPI Gloss Level G3), MPI #52.

END OF SECTION 09 91 24

SECTION 10 14 23.16 - ROOM-IDENTIFICATION PANEL SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes room-identification signs that are directly attached to the building.

B. Related Requirements:

1. Section 101300 "Directories" for building directories.
2. Section 101416 "Plaques" for one-piece, solid metal signs, with or without frames, that are used for high-end room-identification.

1.2 DEFINITIONS

A. Accessible: In accordance with the accessibility standard.

1.3 COORDINATION

A. Furnish templates for placement of sign-anchorage devices embedded in permanent construction by other installers.

B. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For room-identification signs.

1. Include fabrication and installation details and attachments to other work.
2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least half size.

C. Product Schedule: For room-identification signs. Use same designations indicated on Drawings or specified.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For signs to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Tools: One set(s) of specialty tools for assembling signs and replacing variable sign components.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer of products.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify locations of anchorage devices and electrical service embedded in permanent construction by other installers by field measurements before fabrication, and indicate measurements on Shop Drawings.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of finishes beyond normal weathering.
b. Deterioration of embedded graphic image.
c. Separation or delamination of sheet materials and components.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in the ABA standards of the Federal agency having jurisdiction and ICC A117.1.

2.2 ROOM-IDENTIFICATION SIGNS

A. General: Refer to product indicated on Drawings.

B. Room-Identification Sign: Sign system with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Vista System, LLC

2.3 SIGN MATERIALS

A. Aluminum Sheet and Plate: ASTM B209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

B. Aluminum Extrusions: ASTM B221, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

C. Acrylic Sheet: ASTM D4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).

D. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.

2.4 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:

1. Use concealed fasteners and anchors unless indicated to be exposed.
2. For exterior exposure, furnish nonferrous-metal or hot-dip galvanized devices unless otherwise indicated.
3. Exposed Metal-Fastener Components, General:

a. Fabricated from same basic metal and finish of fastened sign unless otherwise indicated.
b. Fastener Heads: Use flathead oval countersunk screws and bolts with tamper-resistant Allen-head slots unless otherwise indicated.

4. Sign Mounting Fasteners:

a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material or screwed into back of sign assembly unless otherwise indicated.

b. Through Fasteners: Exposed metal fasteners matching sign finish, with type of head indicated, and installed in predrilled holes.

B. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch thick, with adhesive on both sides.

2.5 FABRICATION

A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.

1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
3. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.

B. Subsurface-Applied Graphics: Apply graphics to back face of clear face-sheet material to produce precisely formed image. Image shall be free of rough edges.

C. Subsurface-Etched Graphics: Reverse etch back face of clear face-sheet material. Fill resulting copy with manufacturer's standard enamel. Apply opaque manufacturer's standard background color coating over enamel-filled copy.

D. Signs with Changeable Message Capability: Fabricate signs to allow insertion of changeable messages as follows:

1. For slide-in changeable inserts, fabricate slot without burrs or constrictions that inhibit function. Furnish initial changeable insert. Subsequent changeable inserts are by Owner.

2.6 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, Class I, 0.018 mm or thicker.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Install signs so they do not protrude or obstruct according to the accessibility standard.
3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.

B. Accessibility: Install signs in locations on walls according to the accessibility standard.

C. Mounting Methods:

1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.

    a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
    b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.

2. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.
3. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.
4. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.

3.2 ADJUSTING AND CLEANING

A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or

components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

B. Remove temporary protective coverings and strippable films as signs are installed.

C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 10 14 23.16

SECTION 10 28 00 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Public-use washroom accessories.
2. Underlavatory guards.
3. Custodial accessories.

1.2 COORDINATION

A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.

B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.3 ACTION SUBMITTALS

A. Product Data: For each product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
3. Include electrical characteristics.

B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.

1. Identify locations using room designations indicated.
2. Identify accessories using designations indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For accessories to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 UNDERLAVATORY GUARDS

A. Underlavatory Guard:

1. General: Refer to product indicated on Drawings.
2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Buckaroos, Inc.
    b. Plumberex Specialty Products, Inc.
    c. Truebro; IPS Corporation

3. Description: Insulating pipe covering for supply and drain piping assemblies that prevents direct contact with and burns from piping; allow service access without removing coverings.
4. Material and Finish: Antimicrobial, molded plastic, white.

2.3 CUSTODIAL ACCESSORIES

A. General - Refer to product indicated on Drawings.

B. Source Limitations: Obtain each type of custodial accessory from single source from single manufacturer.

C. Custodial Utility Shelf:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. ASI-American Specialties, Inc.
    b. Bobrick Washroom Equipment, Inc
    c. Bradley Corporation

2. Size: As indicated on Drawings.

D. Custodial Mop and Broom Holder:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. ASI-American Specialties, Inc.
b. Bobrick Washroom Equipment, Inc
c. Bradley Corporation

2. Description: Unit with shelf, hooks, holders, and rod suspended beneath shelf.
3. Length: 36 inches.
4. Hooks: Four.
5. Mop/Broom Holders: Three, spring-loaded, rubber hat, cam type.
6. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

a. Shelf: Not less than nominal 0.05-inch- thick stainless steel.
b. Rod: Approximately 1/4-inch- diameter stainless steel.

2.4 MATERIALS

A. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, 0.031-inch- minimum nominal thickness unless otherwise indicated.

B. Steel Sheet: ASTM A1008/A1008M, Designation CS (cold rolled, commercial steel), 0.036-inch- minimum nominal thickness.

C. Galvanized-Steel Sheet: ASTM A653/A653M, with G60 hot-dip zinc coating.

D. Galvanized-Steel Mounting Devices: ASTM A153/A153M, hot-dip galvanized after fabrication.

E. Fasteners: Screws, bolts, and other devices of same material as accessory unit, unless otherwise recommended by manufacturer or specified in this Section, and tamper and theft resistant where exposed, and of stainless or galvanized steel where concealed.

F. Chrome Plating: ASTM B456, Service Condition Number SC 2 (moderate service).

2.5 FABRICATION

A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.

B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION OF TOILET, BATH, AND LAUNDRY ACCESSORIES

A. Install accessories in accordance with manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

1. Remove temporary labels and protective coatings.

3.2 ADJUSTING AND CLEANING

A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.

B. Clean and polish exposed surfaces in accordance with manufacturer's written instructions.

END OF SECTION 10 28 00

SECTION 10 44 13 - FIRE PROTECTION CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire-protection cabinets for the following:

a. Portable fire extinguisher.

B. Related Requirements:

1. Section 104416 "Fire Extinguishers" for portable, hand-carried fire extinguishers accommodated by fire-protection cabinets.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing recessed-, semirecessed-, or surface-mounting method and relationships of box and trim to surrounding construction.

B. Shop Drawings: For fire-protection cabinets.

1. Include plans, elevations, sections, details, and attachments to other work.

C. Product Schedule: For fire-protection cabinets. Indicate whether recessed, semirecessed, or surface mounted. Coordinate final fire-protection cabinet schedule with fire-extinguisher schedule to ensure proper fit and function.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance Data: For fire-protection cabinets to include in maintenance manuals.

1.4 COORDINATION

A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain fire-protection cabinets, accessories, and fire extinguishers from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E814 for fire-resistance rating of walls where they are installed.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 FIRE-PROTECTION CABINET

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Guardian Fire Equipment, Inc
2. JL Industries; Activar Construction Products Group, Inc.
3. Larsen's Manufacturing Company

B. Cabinet Construction: Nonrated.

C. Cabinet Material: Stainless steel sheet.

D. Semirecessed Cabinet: One-piece combination trim and perimeter door frame overlapping surrounding wall surface, with exposed trim face and wall return at outer edge (backbend).

1. Square-Edge Trim: 1-1/4- to 1-1/2-inch backbend depth.

E. Cabinet Trim Material: Stainless steel sheet.

F. Door Material: Stainless steel sheet.

G. Door Style: Fully glazed panel with frame.

H. Door Glazing: Acrylic sheet.

1. Acrylic Sheet Color:

a. Clear transparent acrylic sheet.

I. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

1. Provide recessed door pull and friction latch.
2. Provide continuous hinge, of same material and finish as trim, permitting door to open 180 degrees.

J. Accessories:

1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
2. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as directed by Architect.

    a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."

        1) Location: Applied to cabinet glazing.
        2) Application Process: Silk-screened,,Decals,,Pressure-sensitive vinyl letters.
        3) Lettering Color: Red.
        4) Orientation: Vertical.

K. Materials:

1. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304.

    a. Finish: ASTM A480/A480M No. 4 directional satin finish,.

2. Tempered Float Glass: ASTM C1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear).

2.4 FABRICATION

A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.

1. Weld joints and grind smooth.
2. Miter corners and grind smooth.
3. Provide factory-drilled mounting holes.
4. Prepare doors and frames to receive locks.

B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.

1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
2. Fabricate door frames of one-piece construction with edges flanged.
3. Miter and weld perimeter door frames and grind smooth.

2.5 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.

C. Finish fire-protection cabinets after assembly.

D. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls and partitions for suitable framing depth and blocking where recessed and semirecessed cabinets will be installed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare recesses for semirecessed fire-protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION OF FIRE-PROTECTION CABINETS

A. General: Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at height indicated below:

1. Fire-Protection Cabinet Mounting Height: 42 inches above finished floor to top of fire extinguisher.

B. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.

1. Unless otherwise indicated, provide recessed fire-protection cabinets. If wall thickness is inadequate for recessed cabinets, provide semirecessed fire-protection cabinets.
2. Provide inside latch and lock for break-glass panels.
3. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.

C. Identification:

1. Apply decals vinyl lettering at locations indicated.

2. Apply decals orvinyl lettering on field-painted fire-protection cabinets after painting is complete.

3.4 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as fire-protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.

B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet and mounting bracket manufacturers.

E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 10 44 13

SECTION 10 44 16 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

B. Related Requirements:

1. Section 104413 "Fire Protection Cabinets."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.

B. Product Schedule: For fire extinguishers. Coordinate final fire-extinguisher schedule with fire-protection cabinet schedule to ensure proper fit and function.

1.3 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.5 COORDINATION

A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure of hydrostatic test according to NFPA 10 when testing interval required by NFPA 10 is within the warranty period.
b. Faulty operation of valves or release levers.

2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

1. Provide fire extinguishers approved, listed, and labeled by FM Global.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Guardian Fire Equipment, Inc
b. JL Industries; Activar Construction Products Group, Inc.
c. Larsen's Manufacturing Company

2. Source Limitations: Obtain fire extinguishers, fire-protection cabinets, and accessories, from single source from single manufacturer.
3. Valves: Manufacturer's standard.
4. Handles and Levers: Manufacturer's standard.
5. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging.

B. Multipurpose Dry-Chemical Type in Steel Container : UL-rated 3-A:40-B:C, 5-lb and4-A:60-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

2.3 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or black baked-enamel finish.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Guardian Fire Equipment, Inc
    b. JL Industries; Activar Construction Products Group, Inc.
    c. Larsen's Manufacturing Company

2. Source Limitations: Obtain mounting brackets and fire extinguishers from single source from single manufacturer.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.

1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

    a. Orientation: Vertical.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

1. Mounting Height: Top of fire extinguisher to be at 42 inches above finished floor.

END OF SECTION 10 44 16

SECTION 10 73 16.13 - METAL CANOPIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Furnishing and installation of extruded aluminum overhead cantilever supported canopies.

1.2 DEFINITIONS

A. ASTM International (ASTM):

1. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength.
2. ASTM A792 - Standard Specification for Steel Sheet, 55 percent Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
3. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
4. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
5. ASTM E2950 - Standard Specification for Metal Canopy Systems.

B. American Society of Civil Engineers (ASCE):

1. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures.

C. American Welding Society (AWS):

1. AWS D1.1 - Structural Welding Code.

D. American Architectural Manufacturer's Association

1. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix).

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer's data for Metal Canopies.
2. Preparation instructions and recommendations.
3. Typical installation methods.

4. Include information for factory finish, accessories, and other required components.

B. Shop Drawings:

1. Details of materials, construction, and finish. Include relationship with adjacent construction.
2. Layout of each canopy or shelter, showing the location of supporting members
3. Include elevations and details.
4. Signed and sealed by the qualified professional engineer responsible for their preparation.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For manufacturer, fabricator, Installer.

B. Delegated design engineer qualifications.

C. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For {Insert systems, subsystems, or equipment}.

B. Warranty Documentation:

1. Manufacturers' special warranties.

1.7 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturers: A company specializing in manufacturing products specified in this section with a minimum of five years of documented experience.
2. Installers: Fabricator of products Entity that employs installers and supervisors who are trained and approved by the manufacturer.
3. Delegated Design Engineer: A professional engineer who is legally qualified to practice in the state where the Project is located and who is experienced in providing engineering services of the type indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the project site ready for installation whenever possible.

B. Store and handle in strict compliance with the manufacturer's written instructions and recommendations.

C. Protect from damage due to weather, excessive temperature, and construction operations.

1.9 WARRANTY

A. Manufacturer's standard warranty.

1. Correct defective work.

2. Warranty Period: 3-year(s) period after Date of Substantial Completion

B. Special Warranty: Manufacturer and Installer agree to repair or replace {components of} metal canopies that fail(s) in materials or workmanship within the specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: 5 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Mapes Canopies

B. Skyscape Canopies

2.2 SOURCE LIMITATIONS

A. Provide each type of product from a single manufacturing source to ensure uniformity.

2.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design Metal Canopies.

B. Standards compliance: Pre-engineered system complying with ASTM E2950 and in accordance with ASCE 7.

1. Loading: As indicated on Drawings and in compliance with local authorities having jurisdiction

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes. No buckling, joint seal failure, fastener failure, or component failure.

1. Ambient Temperature Range: Up to 120 degrees F

2. Surface Temperature Range: Up to 180 degrees F

D. Fabrication: Fabricate canopies as an integrated set of welded components ready for installation on Project site.

2.4 EXTRUDED ALUMINUM CANOPY COMPONENTS:

A. Decking: 1. Decking shall consist of louvered blades (.110" extruded aluminum).

B. Intermediate framing members:

1. Intermediate framing members shall be extruded aluminum, alloy 6063-T6, in profile and thickness shown in current Mapes brochures.

C. Cantilever supported brackets shall be standard finish.

D. Fascia shall be custom extruded 24" Smooth Face style

E. Smooth aluminum:

1. Extrusions: Meeting requirements of ASTM B221, alloy 6063-T6.

F. Sealants: Single component clear 100 percent silicone.

G. Accessories: Flashings, brackets, and other items as necessary for complete system.

H. Fasteners: Non-structural:

1. Stainless steel. ASTM F593.

2.5 FABRICATION OF METAL CANOPIES

A. See drawings for size and configurations. Fabricate system in accordance with approved shop See drawings for size and configurations. Fabricate system in accordance with approved shop drawings. Accurately form components to suite each other and to building structure.

B. Extruded aluminum canopies are shipped with the materials precut to size for field assembly.

C. Fit and weld all joints and components in largest practical sizes for delivery to site.

D. Exposed Fastenings: Unobtrusively locate, consistent with design of component except where specifically noted otherwise.

E. Connections shall be mechanically assembled utilizing 3/16 fasteners with a minimum shear stress of 350 lb. Pre-welded or factory-welded connections are not acceptable.

F. Supply components required for anchorage of framing. Fabricate anchors and related components of same material and finish as framing, except where specifically noted otherwise.

2.6 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in the same piece are unacceptable. Variations in the appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 FINISHES

A. PVDF Fluoropolymer Color Finish: AAMA 621-01, with a minimum of 70% Kynar/Hylar polyvinylidene fluoride resins of 1.0 mil total dry film thickness or thicker.

1. Color and Gloss: Match Architect's sample

PART 3 - EXAMINATION

A. Examine substrates and conditions, by manufacturer's approved installer for compliance with requirements for installation tolerances, and other conditions affecting the performance of the Work.

B. Confirm that the surface area where canopy is to be installed is complete in construction and workmanship. Verify that wall substrate anchors are acceptable and ready to receive work. Confirm dimensions and locations of attachment points are as shown on approved shop drawings. Any discrepancies shall be reviewed with the Architect, prior to installation. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best results for the substrate under the project conditions

3.3 ERECTION OF METAL CANOPIES

A. Install in accordance with manufacturer's instructions approved submittals and in proper relationship with adjacent construction.

1. Install members plumb and square, free from warp or twist, securely anchored to substrates with appropriate fasteners and accessories.
2. Maintain dimensional tolerances and alignment with adjacent work.
3. Provide required anchors for connecting framing to structure.
4. Conceal bolts and screws whenever possible. Where not concealed, use flush countersunk fasteners
5. Ensure joints are hairline tight and surfaces flush with adjacent components.

B. ADJUSTING

1. Maximum Variation from Plumb: 1/4-inch per story, non-cumulative. Maximum Misalignment from True Position: 1/4-inch

3.4 REPAIRING

A. After completing installation, inspect exposed finishes and repair damaged finishes according to manufacturer's instructions

3.5 CLEANING

A. Clean products in accordance with the manufacturer's recommendations.

END OF SECTION 10 73 16

SECTION 13 34 19 - METAL BUILDING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal building systems.
2. Structural-steel framing.
3. Metal roof panels.
4. Metal soffit panels.
5. Thermal insulation.
6. Accessories.

B. Related Requirements:

1. Division 03 concrete Sections for anchor rod installation, concrete, reinforcement, and formwork requirements.
2. Section 077253 "Snow Guards" for devices designed to hold snow on the roof surface.
3. Section 083613 "Sectional Doors" for sectional vehicular doors in metal building systems.

1.2 DEFINITIONS

A. Terminology Standard: See MBMA's "Metal Building Systems Manual" for definitions of terms for metal building system construction not otherwise defined in this Section or in standards referenced by this Section.

1.3 COORDINATION

A. Coordinate sizes and locations of concrete foundations and casting of anchor-rod inserts into foundation walls and footings. Anchor rod installation, concrete, reinforcement, and formwork requirements are specified in Division 03 concrete Sections.

B. Coordinate imposed load of HVAC and fire protection specified in other Sections with structural performance requirements specified in this Section.

C. Coordinate metal panel assemblies with rain drainage work, flashing, trim, and construction of supports and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conferences: Conduct conferences at Project site by web conference.

1. Metal Building Systems Conference: Review methods and procedures related to metal building systems including, but not limited to, the following:

    a. Condition of foundations and other preparatory work performed by other trades.
    b. Structural load limitations.
    c. Construction schedule. Verify availability of materials and erector's personnel, equipment, and facilities needed to make progress and avoid delays.
    d. Required tests, inspections, and certifications.
    e. Unfavorable weather and forecasted weather conditions and impact on construction schedule.

2. Metal Building Roof Panel Conference: Review methods and procedures related to metal roof panel assemblies including, but not limited to, the following:

    a. Compliance with requirements for purlin and rafter conditions, including flatness and attachment to structural members.
    b. Structural limitations of purlins and rafters during and after roofing.
    c. Flashings, special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect metal roof panels.
    d. Temporary protection requirements for metal roof panel assembly during and after installation.
    e. Roof observation and repair after metal roof panel installation.

3. Metal Building Wall Panel Conference: Review methods and procedures related to metal wall panel assemblies including, but not limited to, the following:

    a. Compliance with requirements for support conditions, including alignment between and attachment to structural members.
    b. Structural limitations of girts and columns during and after wall panel installation.
    c. Flashings, special siding details, wall penetrations, openings, and condition of other construction that will affect metal wall panels.
    d. Temporary protection requirements for metal wall panel assembly during and after installation.
    e. Wall observation and repair after metal wall panel installation.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following

    a. Metal roof panels.

b. Metal soffit panels.
c. Thermal insulation and vapor-retarder facings.

B. Shop Drawings: By manufacturer of metal building systems. Indicate components by others. Include full building plan, elevations, sections, details, and the following:

1. Anchor-Rod Plans: Submit anchor-rod plans and templates before foundation work begins. Include location, diameter, and minimum required projection of anchor rods required to attach metal building to foundation. Indicate column reactions at each location.
2. Structural-Framing Drawings: Indicate complete fabrication of primary and secondary framing; include provisions for openings. Indicate welds and bolted connections, distinguishing between shop and field applications. Include transverse cross-sections.

    a. Indicate provisions for attaching mezzanines and pipe racks.

3. Metal Panel Layout Drawings: Indicate roof and wall. layouts of panels including methods of support. Include details of edge conditions, joints, panel profiles, corners, anchorages, clip spacing, trim, flashings, closures, and special details. Distinguish between factory- and field-assembled work; indicate locations of exposed fasteners.

    a. Indicate roof-mounted items including roof hatches, equipment supports, pipe supports and penetrations, lighting fixtures, and items mounted on roof curbs.
    b. Indicate wall-mounted items including personnel doors, vehicular doors, windows, louvers, and lighting fixtures.
    c. Indicate translucent panels.

4. Accessory Drawings: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches:

    a. Flashing and trim.
    b. Gutters.
    c. Downspouts.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.

D. Samples for Verification: Actual sample of finished products for each type of exposed finish.

1. Panels: Manufacturers' standard size. Include fasteners, closures, and other exposed panel accessories.
2. Flashing and Trim: Manufacturers' standard size. Include fasteners and other exposed accessories.
3. Vapor-Retarder Facings: Minimum 6-inch- square Samples.
4. Accessories: Samples for each type of accessory.

E. Delegated Design Submittals: For metal building systems, including analysis data

signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Letter of Design Certification: Signed and sealed by a qualified professional engineer. Include the following:

1. Name and location of Project.
2. Order number.
3. Name of manufacturer.
4. Name of Contractor.
5. Building dimensions including width, length, height, and roof slope.
6. Indicate compliance with AISC standards for hot-rolled steel and AISI standards for cold-rolled steel, including edition dates of each standard.
7. Governing building code and year of edition.
8. Design Loads: Include dead load, roof live load, collateral loads, roof snow load, deflection, wind loads/speeds and exposure, seismic design category or effective peak velocity-related acceleration/peak acceleration, and auxiliary loads (cranes).
9. Load Combinations: Indicate that loads were applied acting simultaneously with concentrated loads, in accordance with governing building code.
10. Building-Use Category: Indicate category of building use and its effect on load importance factors.

B. Erector Certificates: For qualified erector, from manufacture.

C. Welding certificates.

D. Material Test Reports: For each of the following products, by a qualified testing agency:

1. Structural steel including chemical and physical properties.
2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
3. Tension-control, high-strength, and bolt-nut-washer assemblies.
4. Shop primers.
5. Nonshrink grout.

E. Source quality control reports.

F. Field quality control reports.

G. Delegated Design Engineer Qualifications: For metal building system.

H. Sample Warranties: For special warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panel finishes and door hardware.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Accreditation: Manufacturer's facility accredited according to IAS AC472, "Accreditation Criteria for Inspection Programs for Manufacturers of Metal Building Systems."
2. Manufacturer Qualifications: A qualified manufacturer.
3. Engineering Responsibility: Metal building system design and preparation of comprehensive engineering analysis and Shop Drawings by a professional engineer who is legally qualified to practice in in jurisdiction where Project is located and who is experienced in providing engineering services of the type indicated.
4. Manufactured specified products with satisfactory service on two similar installations in the last seven years.

    a. Project Experience List: Provide contact names and addresses for completed projects.

B. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in in jurisdiction where Project is located and who is experienced in providing engineering services of the type indicated.

C. Erector Qualifications: An experienced erector who specializes in erecting and installing work similar in material, design, and extent to that indicated for this Project and who is acceptable to manufacturer.

1. Regularly installs specified products.
2. Installed specified products with satisfactory service on two similar installations in the last seven years.

D. Land Surveyor Qualifications: A professional land surveyor who practices in jurisdiction where Project is located and who is experienced in providing surveying services of the kind indicated.

E. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:

1. AWS D1.1/D1.1M. "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M. "Structural Welding Code - Sheet Steel."

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, sheets, panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Protect foam-plastic insulation as follows:

1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver foam-plastic insulation materials to Project site before installation time.
3. Complete installation and concealment of foam-plastic materials as rapidly as possible in each area of construction.

1.10 FIELD CONDITIONS

A. Weather Limitations: Proceed with panel installation only when weather conditions permit metal panels to be installed in accordance with manufacturers' written installation instructions and warranty requirements.

1.11 WARRANTY

A. Special Warranty on Metal Panel Finishes: Manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 25 years from date of Substantial Completion.

B. Special Weathertightness Warranty for Standing-Seam Metal Roof Panels: Manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that leak or otherwise fail to remain weathertight within specified warranty period.

1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain metal building system components, including primary and secondary framing and metal panel assemblies, from single source from single manufacturer.

1. Butler Manufacturing Company; a division of BlueScope Buildings North America, Inc
2. Nucor Building Systems; a Nucor company
3. Heavy Structures a division of BlueScope Buildings North America, Inc
4. J&M Steel
5. Arco Steel
6. Alliance Steel
7. Varco Pruden
8. Americam Building
9. **Red Dot Buildings**

B. Source Limitations: Obtain metal building system components, including primary and secondary framing and metal panel assemblies, from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design metal building system.

B. Structural Performance: Metal building systems to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated in accordance with procedures in MBMA's "Metal Building Systems Manual":

1. Design Loads: As indicated on Drawings.
2. Deflection and Drift Limits:

    a. Design metal building system assemblies to withstand serviceability design loads without exceeding deflections and drift limits recommended in AISC's "Design Guide No. 3: Serviceability Design Considerations for Steel Buildings."
    b. Deflection to be no greater than the following:

        1) Purlins and Rafters: Vertical deflection as indicated on the drawings.
        2) Girts: Horizontal deflection as indicated on the drawings.
        3) Metal Roof Panels: Vertical deflection as indicated on the drawings.
        4) Metal Wall Panels: Horizontal deflection as indicated on the drawings.
        5) Design secondary-framing system to accommodate deflection of primary framing and construction tolerances, and to maintain clearances at openings.

C. Seismic Performance: Metal building system to withstand the effects of earthquake motions determined in accordance with As indicated on drawings..

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

E. Fire-Resistance Ratings: Where assemblies are indicated to have a fire-resistance rating, provide metal panel assemblies identical to those of assemblies tested for fire resistance per ASTM E119 or ASTM E108 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL Product iQ, FM Approvals' "Approval Guide," or from the listings of another qualified testing agency.

F. Fire Propagation Characteristics: Exterior wall assemblies containing foam plastics pass NFPA 285 fire test.

G. Structural Performance for Metal Panels: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing in accordance with ASTM E1592:

1. Wind Loads: As indicated on Drawings.

H. Air Infiltration for Metal Roof Panels: Air leakage of not more than 0.06 cfm/sq. ft. when tested in accordance with ASTM E1680 or ASTM E283/E283M at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft..

I. Air Infiltration for Metal Wall Panels: Air leakage of not more than 0.06 cfm/sq. ft. when tested in accordance with ASTM E283/E283M at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft..

J. Water Penetration for Metal Roof Panels: No water penetration when tested in accordance with ASTM E1646 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft..

K. Water Penetration for Metal Wall Panels: No water penetration when tested in accordance with ASTM E331 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft..

L. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.

1. Uplift Rating: UL 90.

M. Thermal Performance for Opaque Elements: Provide the following maximum U-factors and minimum R-values when tested in accordance with ASTM C1363 or ASTM C518:

1. Roof:

a. U-Factor: .47.
b. R-Value: R 30 min.

2. Walls:

    a. U-Factor: .0909.
    b. R-Value: R 11 min.

2.3 METAL BUILDING SYSTEMS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Alliance Steel, Inc
2. American Buildings Company; a Nucor company
3. BlueScope Buildings North America, Inc.
4. Nucor Building Systems; a Nucor company
5. Varco-Pruden Buildings; a division of BlueScope Buildings North America, Inc.
6. J&M Steel

B. System Description: Provide a complete, integrated set of mutually dependent components and assemblies that form a metal building system capable of withstanding structural and other loads, thermally induced movement, and exposure to weather without failure or infiltration of water into building interior.

1. Primary-Frame Type:

    a. Rigid Clear Span: Solid-member, structural-framing system without interior columns.

2. End-Wall Framing:

    a. Manufacturer's standard, for buildings not required to be expandable, consisting of primary frame, capable of supporting one-half of a bay design load, and end-wall columns.

3. Secondary-Frame Type: Manufacturer's standard purlins and joists and exterior-framed (bypass) girts.
4. Eave Height: 33 ft..
5. Bay Spacing: 22'-3".
6. Roof Slope: 1/4 inch per 12 inches.
7. Roof System: Manufacturer's standard standing-seam, trapezoidal-rib, metal roof panels.

    a. Liner Panels: Tapered rib.

8. Exterior Wall System: Manufacturer's standard exposed-fastener, tapered-rib, concealed-fastener, flush-profile, foamed-insulation-core metal wall panels.

2.4 STRUCTURAL-STEEL FRAMING

A. Structural Steel: Comply with AISC 360.

B. Bolted Connections: Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts."

C. Cold-Formed Steel: Comply with AISI S100 for design requirements and allowable stresses.

D. Primary Framing: Manufacturer's standard primary-framing system, designed to withstand required loads and specified requirements. Primary framing includes transverse and lean-to frames; rafters, rake, and canopy beams; sidewall, intermediate, end-wall, and corner columns; and wind bracing.

1. General: Provide frames with attachment plates, bearing plates, and splice members. Factory drill for field-bolted assembly. Provide frame span and spacing indicated.

    a. Slight variations in span and spacing may be acceptable if necessary to comply with manufacturer's standard, as approved by Architect.

2. Rigid Clear-Span Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Interior columns are not permitted.
3. Frame Configuration: Multiple gable.
4. Exterior Column: Tapered.
5. Rafter: Tapered.

E. End-Wall Framing: Manufacturer's standard primary end-wall framing fabricated for field-bolted assembly to comply with the following:

1. End-Wall and Corner Columns: I-shaped sections fabricated from structural-steel shapes; shop-welded, built-up steel plates; or C-shaped, cold-formed, structural-steel sheet.

F. Secondary Framing: Manufacturer's standard secondary framing, including purlins, girts, eave struts, flange bracing, base members, gable angles, clips, headers, jambs, and other miscellaneous structural members. Unless otherwise indicated, fabricate framing from either cold-formed, structural-steel sheet or roll-formed, metallic-coated steel sheet, prepainted with coil coating, to comply with the following:

1. Purlins:

    a. C- or Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; minimum 2-1/2-inch- wide flanges.

2. Girts: C- or Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes. Form ends of Z-sections with stiffening lips angled 40 to 50 degrees from flange, with minimum 2-1/2-inch- wide flanges.
3. Eave Struts: Unequal-flange, C-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; to provide adequate backup for metal panels.
4. Flange Bracing: Minimum 2-by-2-by-1/8-inch structural-steel angles or 1-inch-diameter, cold-formed structural tubing to stiffen primary-frame flanges.
5. Sag Bracing: Minimum 1-by-1-by-1/8-inch structural-steel angles.

6. Base or Sill Angles: Manufacturer's standard base angle, minimum 3-by-2-inch, fabricated from zinc-coated (galvanized) steel sheet.
7. Purlin and Girt Clips: Manufacturer's standard clips fabricated from steel sheet. Provide galvanized clips where clips are connected to galvanized framing members.
8. Framing for Openings: Channel shapes; fabricated from cold-formed, structural-steel sheet or structural-steel shapes. Frame head and jamb of door openings and head, jamb, and sill of other openings.
9. Miscellaneous Structural Members: Manufacturer's standard sections fabricated from cold-formed, structural-steel sheet; built-up steel plates; or zinc-coated (galvanized) steel sheet; designed to withstand required loads.

G. Canopy Framing: Manufacturer's standard structural-framing system, designed to withstand required loads; fabricated from shop-welded, built-up steel plates or structural-steel shapes. Provide frames with attachment plates and splice members, factory drilled for field-bolted assembly.

1. Type: As indicated.

H. Bracing: Provide adjustable wind bracing as follows:

1. Rods: ASTM A36/A36M; ASTM A572/A572M, Grade 50; or ASTM A529/A529M, Grade 50; minimum 1/2-inch- diameter steel; threaded full length or threaded a minimum of 6 inches at each end.
2. Angles: Fabricated from structural-steel shapes to match primary framing, of size required to withstand design loads.

I. Anchor Rods: Headed anchor rods as indicated in Anchor Rod Plan for attachment of metal building to foundation.

J. Materials:

1. W-Shapes: ASTM A992/A992M; ASTM A572/A572M, Grade 50; or ASTM A529/A529M, Grade 50.
2. Channels, Angles, M-Shapes, and S-Shapes: ASTM A36/A36M; ASTM A572/A572M, Grade 50 or 55; or ASTM A529/A529M, Grade 50.
3. Plate and Bar: ASTM A36/A36M; ASTM A572/A572M, Grade 50 or 55; or ASTM A529/A529M, Grade 50.
4. Steel Pipe: ASTM A53/A53M, Type E or S, Grade B.
5. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade B or C, structural tubing.
6. Structural-Steel Sheet: Hot-rolled, ASTM A1011/A1011M, Structural Steel (SS), Grades 30 through 55, or High-Strength Low-Alloy Steel (HSLAS) or High-Strength Low-Alloy Steel with Improved Formability (HSLAS-F), Grades 45 through 70; or cold-rolled, ASTM A1008/A1008M, Structural Steel (SS), Grades 25 through 80, or HSLAS, Grades 45 through 70.
7. Metallic-Coated Steel Sheet: ASTM A653/A653M, SS, Grades 33 through 80, or HSLAS or HSLAS-F, Grades 50 through 80; with G60 coating designation; mill phosphatized.
8. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to

comply with ASTM A755/A755M.

a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, SS, Grades 33 through 80, or HSLAS or HSLAS-F, Grades 50 through 80; with G90 coating designation.
b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792/A792M, SS, Grade 50 or 80; with Class AZ50 coating.

9. Joist Girders: Manufactured in accordance with "Standard Specifications for Joist Girders," in SJI's "Standard Specifications, Load Tables, and Weight Tables for Steel Joists and Joist Girders"; with steel-angle, top- and bottom-chord members, and end- and top-chord arrangements as indicated on Drawings and required for primary framing.
10. Steel Joists: Manufactured in accordance with "Standard Specifications for Open Web Steel Joists, K-Series," in SJI's "Standard Specifications, Load Tables, and Weight Tables for Steel Joists and Joist Girders"; with steel-angle, top- and bottom-chord members, and end- and top-chord arrangements as indicated on Drawings and required for secondary framing.
11. Non-High-Strength Bolts, Nuts, and Washers: ASTM A307, Grade A, carbon-steel, hex-head bolts; ASTM A563/A563M carbon-steel hex nuts; and ASTM F844 plain (flat) steel washers.

    a. Finish: Plain.

12. High-Strength Bolts, Nuts, and Washers, Grade A325 (Grade A325M): ASTM F3125/F3125M, Type 1, heavy-hex steel structural bolts; ASTM A563/A563M, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

    a. Finish: Plain.

13. High-Strength Bolts, Nuts, and Washers, Grade A490 (Grade A490M): ASTM F3125/F3125M, Type 1, heavy-hex steel structural bolts or Grade F2280 tension-control, bolt-nut-washer assemblies with splined ends; ASTM A563/A563M, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.
14. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 1, heavy-hex head assemblies consisting of steel structural bolts with splined ends; ASTM A563/A563M, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1 hardened carbon-steel washers.

    a. Finish: Plain.

15. Headed Anchor Rods: ASTM F1554, Grade 36.

    a. Configuration: Straight.
    b. Nuts: ASTM A563/A563M, hex carbon steel.
    c. Plate Washers: ASTM A36/A36M carbon steel.
    d. Washers: ASTM F436/F436M, hardened carbon steel.
    e. Finish: Plain.

K. Finish: Factory primed. Apply specified primer immediately after cleaning and pretreating.

1. Clean and prepare in accordance with SSPC-SP2.
2. Coat with manufacturer's standard primer. Apply primer to primary and secondary framing to a minimum dry film thickness of 1 mil.

a. Prime secondary framing formed from uncoated steel sheet to a minimum dry film thickness of 0.5 mil on each side.

2.5 METAL ROOF PANELS

A. Solar Reflectance Index:

1. Solar Reflectance Index (SRI): Three-year-aged SRI not less than 64 when calculated in accordance with ASTM E1980, based on testing identical products by a qualified testing agency.

B. Standing-Seam, Trapezoidal-Rib, Metal Roof Panels : Formed with raised trapezoidal ribs at panel edges and intermediate stiffening ribs symmetrically spaced between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.024-inch nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

a. Exterior Finish: Two-coat fluoropolymer.
b. 24-gauge galvanized steel, G90 coating, ASTM A 653, G90.

2. Clips: One-piece fixed to accommodate thermal movement.
3. Joint Type: Mechanically seamed.
4. ~~Panel Coverage:~~ **Panel Style: 24 inches wide, with 2 major corrugations, 2 inches high (2-3/4 inches including seam), 24 inches on center**
5. Uplift Rating: UL 90.

C. Finishes:

1. Exposed Coil-Coated Finish:

a. Two-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
b. Paint with exterior colors of "Butler-Cote™" finish system, full-strength, 70 percent "Kynar 500" or "Hylar 5000" fluoropolymer (PVDF) coating.
c. PVDF Coating Warranty: Metal building system manufacturer shall warrant coating for 25 years for the following.

1) Not to peel, crack, or chip.
2) Chalking: Not to exceed ASTM D 4214, #8 rating
3) Fading: Not more than 5 color-difference units, ASTM D 2244

d. Color: As selected by Architect from manufacturer's full range.

2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

2.6 FOAMED-INSULATION-CORE METAL WALL PANELS

A. Concealed-Fastener, Foamed-Insulation-Core Metal Wall Panels : Formed with tongue-and-groove panel edges; designed for sequential installation by interlocking panel edges and mechanically attaching panels to supports using concealed clips or fasteners.

1. As specified in Section 074213.14 “Formed Metal Wall Panels."

2.7 METAL SOFFIT PANELS

A. General: Provide factory-formed metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in side laps. Include accessories required for weathertight installation.

B. Concealed-Fastener, Flush-Profile, Metal Soffit Panels : Formed with vertical panel edges and flush surface; with flush joint between panels; with 1-inch- wide flange for attaching interior finish; designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.024-inch nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

a. Exterior Finish: Fluoropolymer.
b. Color: As selected by Architect from manufacturer's full range.

2. Panel Coverage: 12 inches.
3. Panel Height: 1 inch.

2.8 THERMAL INSULATION

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Bay Insulation Systems; a division of Bay Industries

2. CertainTeed; SAINT-GOBAIN
3. DuPont
4. Johns Manville; a Berkshire Hathaway company

B. Faced Metal Building Insulation: ASTM C991, Type II, glass-fiber-blanket insulation; 0.5-lb/cu. ft. density; 2-inch- wide, continuous, vapor-tight edge tabs; with a flame-spread index of 25 or less.

C. Retainer Strips: For securing insulation between supports, 0.025-inch nominal-thickness, formed, metallic-coated steel or PVC retainer clips colored to match insulation facing.

D. Vapor-Retarder Facing: ASTM C1136, with permeance not greater than 0.02 perm when tested in accordance with ASTM E96/E96M, Desiccant Method.

1. Composition:

a. White polypropylene film facing and fiberglass-polyester-blend fabric backing.

E. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.9 PERSONNEL DOORS AND FRAMES

A. Swinging Personnel Doors and Frames:

1. As specified in Section 081113 "Hollow Metal Doors and Frames."

2.10 HYDRAULIC PIVIOT HANGER DOOR

A. Hydraulic Pivot Hanger door: Manufacturer's standard pivot door assembly including structural frame, door panels, brackets, hardware, and installation accessories.

1. A. As specified in Section 083416 "Hangar Doors."

2.11 WINDOWS

A. Aluminum Windows:

1. As specified in Section 084113 "Aluminum-Framed Entrance and Storefront."

B. Glazing: Comply with requirements specified in Section 088000 "Glazing."

2.12 TRANSLUCENT PANELS

A. As specified in Section 084523 "Fiberglass Sandwich Panel Assemblies."

2.13 ACCESSORIES

A. General: Provide accessories as standard with metal building system manufacturer and as specified. Fabricate and finish accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes. Comply with indicated profiles and with dimensional and structural requirements.

1. Form exposed sheet metal accessories that are without excessive oil-canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

B. Roof Panel Accessories: Provide components required for a complete metal roof panel assembly including copings, fasciae, corner units, ridge closures, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same material as metal roof panels.
2. Clips: Manufacturer's standard, formed from stainless steel sheet, designed to withstand negative-load requirements.
3. Cleats: Manufacturer's standard, mechanically seamed cleats formed from stainless steel sheet or nylon-coated aluminum sheet.
4. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
5. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
6. Thermal Spacer Blocks: Where metal panels attach directly to purlins, provide thermal spacer blocks of thickness required to provide 1-inch standoff; fabricated from extruded polystyrene.

C. Flashing and Trim: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch nominal uncoated steel thickness, prepainted with coil coating; finished to match adjacent metal panels.

1. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers.
2. Opening Trim: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch nominal uncoated steel thickness, prepainted with coil coating. Trim head and jamb of door openings, and head, jamb, and sill of other openings.

D. Gutters: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch nominal uncoated steel thickness, prepainted with coil coating; finished to match roof fascia and rake trim. Match profile of gable trim, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- long sections, sized in accordance with manufacturer's written instructions.

1. Gutter Supports: Fabricated from same material and finish as gutters.

E. Downspouts: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch nominal uncoated steel thickness, prepainted with coil coating; finished to match metal wall panels. Fabricate in minimum 10-ft.- long sections, complete with formed elbows and offsets.

1. Mounting Straps: Fabricated from same material and finish as gutters.

F. Pipe Flashing: Premolded, EPDM pipe collar with flexible aluminum ring bonded to base.

G. Materials:

1. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide fasteners with heads matching color of materials being fastened by means of plastic caps or factory-applied coating.
2. Fasteners for Metal Roof Panels:

    a. Self-drilling or self-tapping, zinc-plated, hex-head carbon-steel screws, with a stainless steel cap or zinc-aluminum-alloy head and EPDM sealing washer.
    b. Self-drilling, Type 410 stainless steel or self-tapping, Type 304 stainless steel or zinc-alloy-steel hex washer head, with EPDM washer under heads of fasteners bearing on weather side of metal panels.

3. Fasteners for Metal Wall Panels:

    a. Self-drilling or self-tapping, zinc-plated, hex-head carbon-steel screws, with EPDM sealing washers bearing on weather side of metal panels.

4. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws with hex washer head.
5. Blind Fasteners: High-strength aluminum or stainless steel rivets.
6. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
7. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.
8. Metal Panel Sealants:

    a. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene-compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape of manufacturer's standard size.
    b. Joint Sealant: ASTM C920; one part elastomeric polyurethane or polysulfide; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended by metal building system manufacturer.

2.14 FABRICATION

A. General: Design components and field connections required for erection to permit easy assembly.

1. Mark each piece and part of the assembly to correspond with previously prepared erection drawings, diagrams, and instruction manuals.
2. Fabricate structural framing to produce clean, smooth cuts and bends. Punch holes of proper size, shape, and location. Members to be free of cracks, tears, and ruptures.

B. Tolerances: Comply with MBMA's "Metal Building Systems Manual" for fabrication and erection tolerances.

C. Primary Framing: Shop fabricate framing components to indicated size and section, with baseplates, bearing plates, stiffeners, and other items required for erection welded into place. Cut, form, punch, drill, and weld framing for bolted field assembly.

1. Make shop connections by welding or by using high-strength bolts.
2. Join flanges to webs of built-up members by a continuous, submerged arc-welding process.
3. Brace compression flange of primary framing with steel angles or cold-formed structural tubing between frame web and purlin web or girt web, so flange compressive strength is within allowable limits for any combination of loadings.
4. Weld clips to frames for attaching secondary framing if applicable, or punch for bolts.
5. Shop Priming: Prepare surfaces for shop priming in accordance with SSPC-SP 2. Shop prime primary framing with specified primer after fabrication.

D. Secondary Framing: Shop fabricate framing components to indicated size and section by roll forming or break forming, with baseplates, bearing plates, stiffeners, and other plates required for erection welded into place. Cut, form, punch, drill, and weld secondary framing for bolted field connections to primary framing.

1. Make shop connections by welding or by using non-high-strength bolts.
2. Shop Priming: Prepare uncoated surfaces for shop priming in accordance with SSPC-SP 2. Shop prime uncoated secondary framing with specified primer after fabrication.

E. Metal Panels: Fabricate and finish metal panels at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.

1. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of metal panel.

2.15 SOURCE QUALITY CONTROL

A. Special Inspection: Owner will engage a qualified special inspector to perform source

quality control inspections and to submit reports.

1. Accredited Manufacturers: Special inspections will not be required if fabrication is performed by an IAS AC472-accredited manufacturer approved by authorities having jurisdiction to perform such Work without special inspection.

    a. After fabrication, submit copy of certificate of compliance to authorities having jurisdiction, certifying that Work was performed in accordance with Contract requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with erector present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Before erection proceeds, survey elevations and locations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments to receive structural framing, with erector present, for compliance with requirements and metal building system manufacturer's tolerances.

1. Engage land surveyor to perform surveying.

C. Proceed with erection only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and prepare surfaces to be painted in accordance with manufacturer's written instructions for each particular substrate condition.

B. Provide temporary shores, guys, braces, and other supports during erection to keep structural framing secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural framing, connections, and bracing are in place unless otherwise indicated.

3.3 ERECTION OF STRUCTURAL FRAMING

A. Erect metal building system in accordance with manufacturer's written instructions and erection drawings.

B. Do not field cut, drill, or alter structural members without written approval from metal building system manufacturer's professional engineer.

C. Set structural framing accurately in locations and to elevations indicated, in accordance with AISC specifications referenced in this Section. Maintain structural stability of frame

during erection.

D. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
3. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

E. Align and adjust structural framing before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with framing. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure will be completed and in service.

F. Primary Framing and End Walls: Erect framing level, plumb, rigid, secure, and true to line. Level baseplates to a true even plane with full bearing to supporting structures, set with double-nutted anchor bolts. Use grout to obtain uniform bearing and to maintain a level base-line elevation. Moist-cure grout for not less than seven days after placement.

1. Make field connections using high-strength bolts installed in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt type and joint type specified.

    a. Joint Type: Snug tightened or pretensioned as required by manufacturer.

G. Secondary Framing: Erect framing level, plumb, rigid, secure, and true to line. Field bolt secondary framing to clips attached to primary framing.

1. Provide rake or gable purlins with tight-fitting closure channels and fasciae.
2. Locate and space wall girts to suit openings such as doors and windows.
3. Provide supplemental framing at entire perimeter of openings, including doors, windows, louvers, ventilators, and other penetrations of roof and walls.

H. Bracing: Install bracing in roof and sidewalls where indicated on erection drawings.

1. Tighten rod and cable bracing to avoid sag.
2. Locate interior end-bay bracing only where indicated.

I. Framing for Openings: Provide shapes of proper design and size to reinforce openings and to carry loads and vibrations imposed, including equipment furnished under mechanical and electrical work. Securely attach to structural framing.

J. Erection Tolerances: Maintain erection tolerances of structural framing within AISC 303.

3.4 INSTALLATION OF METAL PANELS, GENERAL

A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate in accordance with equipment manufacturer's written instructions and to comply with details shown.

C. Examination: Examine primary and secondary framing to verify that structural-panel support members and anchorages have been installed within alignment tolerances required by manufacturer.

1. Examine roughing-in for components and systems penetrating metal panels, to verify actual locations of penetrations relative to seams before metal panel installation.

D. General: Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Field cut metal panels as required for doors, windows, and other openings. Cut openings as small as possible, neatly to size required, and without damage to adjacent metal panel finishes.

a. Field cutting of metal panels by torch is not permitted unless approved in writing by manufacturer.

2. Install metal panels perpendicular to structural supports unless otherwise indicated.
3. Flash and seal metal panels with weather closures at perimeter of openings and similar elements. Fasten with self-tapping screws.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Locate metal panel splices over structural supports with end laps in alignment.
6. Lap metal flashing over metal panels to allow moisture to run over and off the material.

E. Lap-Seam Metal Panels: Install screw fasteners using power tools with controlled torque adjusted to compress EPDM washers tightly without damage to washers, screw threads, or metal panels. Install screws in predrilled holes.

1. Arrange and nest side-lap joints so prevailing winds blow over, not into, lapped joints. Lap ribbed or fluted sheets one full rib corrugation. Apply metal panels and associated items for neat and weathertight enclosure. Avoid "panel creep" or

application not true to line.

F. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.

G. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal panel assemblies. Provide types of gaskets, fillers, and sealants indicated; or, if not indicated, provide types used in tested assemblies meeting "Performance Requirements" Article.

1. Seal metal panel end laps with double beads of tape or sealant the full width of panel. Seal side joints where recommended by metal panel manufacturer.
2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

3.5 INSTALLATION OF METAL ROOF PANELS

A. General: Provide metal roof panels of full length from eave to ridge unless otherwise indicated or restricted by shipping limitations.

1. Install ridge[**and hip**] caps as metal roof panel work proceeds.
2. Flash and seal metal roof panels with weather closures at eaves and rakes. Fasten with self-tapping screws.

B. Standing-Seam Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each standing-seam joint, at location and spacing and with fasteners recommended by manufacturer.

1. Install clips to supports with self-drilling or self-tapping fasteners.
2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
3. Seamed Joint: Crimp standing seams with manufacturer-approved motorized seamer tool so that clip, metal roof panel, and factory-applied sealant are completely engaged.
4. Rigidly fasten eave end of metal roof panels and allow ridge end free movement for thermal expansion and contraction. Predrill panels for fasteners.
5. Provide metal closures at peaks rake edges rake walls and each side of ridge[**and hip**] caps.

C. Lap-Seam Metal Roof Panels: Fasten metal roof panels to supports with exposed fasteners at each lapped joint, at location and spacing recommended by manufacturer.

1. Provide metal-backed sealing washers under heads of exposed fasteners bearing on weather side of metal roof panels.
2. Provide sealant tape at lapped joints of metal roof panels and between panels and protruding equipment, vents, and accessories.
3. Apply a continuous ribbon of sealant tape to weather-side surface of fastenings on end laps and on side laps of nesting-type metal panels, on side laps of ribbed

or fluted metal panels, and elsewhere as needed to make metal panels weatherproof to driving rains.

4. At metal panel splices, nest panels with minimum 6-inch end lap, sealed with butyl-rubber sealant and fastened together by interlocking clamping plates.

D. Metal Fascia Panels: Align bottom of metal panels and fasten with blind rivets, bolts, or self-drilling or self-tapping screws. Flash and seal metal panels with weather closures where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.

E. Metal Roof Panel Installation Tolerances: Shim and align metal roof panels within installed tolerance of 1/4 inch in 20 ft. on slope and location lines and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.6 INSTALLATION OF TRANSLUCENT PANELS

A. Translucent Panels: Attach translucent panels to structural framing with fasteners in accordance with manufacturer's written instructions. Install panels perpendicular to supports unless otherwise indicated. Anchor translucent panels securely in place, with provisions for thermal and structural movement.

1. Provide end laps of not less than 6 inches and side laps of not less than 1-1/2-inch corrugations for metal roof panels.
2. Provide end laps of not less than 4 inches and side laps of not less than 1-1/2-inch corrugations for metal wall panels.
3. Align horizontal laps with adjacent metal panels.
4. Seal intermediate end laps and side laps of translucent panels with translucent mastic.

3.7 INSTALLATION OF METAL SOFFIT PANELS

A. Provide metal soffit panels the full width of soffits. Install panels perpendicular to support framing.

B. Flash and seal metal soffit panels with weather closures where panels meet walls and at perimeter of all openings.

3.8 INSTALLATION OF THERMAL INSULATION

A. General: Install insulation concurrently with metal panel installation, in thickness indicated to cover entire surface, in accordance with manufacturer's written instructions.

1. Set vapor-retarder-faced units with vapor retarder toward warm side of construction unless otherwise indicated. Do not obstruct ventilation spaces except for firestopping.
2. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to the surrounding construction to ensure airtight installation.
3. Install factory-laminated, vapor-retarder-faced blankets straight and true in one-

piece lengths, with both sets of facing tabs sealed, to provide a complete vapor retarder.

4. Install blankets straight and true in one-piece lengths. Install vapor retarder over insulation, with both sets of facing tabs sealed, to provide a complete vapor retarder.

B. Blanket Roof Insulation: Comply with the following installation method:

1. Two-Layers-between-Purlin-with-Spacer-Block Installation: Extend insulation and vapor retarder between purlins. Carry vapor-retarder-facing tabs up and over purlin, overlapping adjoining facing of next insulation course and maintaining continuity of retarder. Install layer of filler insulation over first layer to fill space between purlins formed by thermal spacer blocks. Hold in place with bands and crossbands below insulation.

    a. Thermal Spacer Blocks: Where metal roof panels attach directly to purlins, install thermal spacer blocks.

2. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.

3.9 INSTALLATION OF ACCESSORIES

A. General: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal roof panel assembly, including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
2. Install components for a complete metal wall panel assembly, including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
3. Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by manufacturer.

B. Flashing and Trim: Comply with performance requirements and manufacturer's written installation instructions. Provide concealed fasteners where possible, and set units true to line and level. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without excessive oil-canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 ft. with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion

provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

C. Gutters: Join sections with riveted-and-soldered or lapped-and-sealed joints. Attach gutters to eave with gutter hangers spaced as required for gutter size, but not more than 36 inches o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

D. Downspouts: Join sections with 1-1/2-inch telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c. in between.

1. Provide elbows at base of downspouts to direct water away from building.

E. Roof Curbs: Install curbs at locations indicated on Drawings. Install flashing around bases where they meet metal roof panels.

F. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to panel as recommended by manufacturer.

3.10 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform field quality control special inspections and to submit reports.

1. High-Strength, Field-Bolted Connections: Connections shall be tested and inspected during installation according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
2. Welded Connections: In addition to visual inspection, field-welded connections shall be tested and inspected according to AWS D1.1 and the following inspection procedures, at inspector's option:

a. Liquid Penetrant Inspection: ASTM E 165.
b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted
c. Ultrasonic Inspection: ASTM E 164.
d. Radiographic Inspection: ASTM E 94

B. Product will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.11 CLEANING AND PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint in accordance with ASTM A780/A780M and manufacturer's written instructions.

B. Touchup Painting:

1. After erection, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted structural framing, bearing plates, and accessories.

    a. Clean and prepare surfaces by SSPC-SP 2 or SSPC-SP 3.
    b. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

2. Cleaning and touchup painting are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

C. Metal Panels: Remove temporary protective coverings and strippable films, if any, as metal panels are installed. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

1. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 13 34 19

SECTION 21 00 10 - BASIC MECHANICAL REQUIREMENTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this and the other sections of Divisions 21, 22, and 23.

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements for mechanical installations.

1.3 CONTRACT DOCUMENTS

A. All work shall be executed in accord with the requirements of national, state, and local codes, regulations, and standards applicable to the trade affected.

B. Should any change in the Contract Documents be required to comply with the governing codes, regulations, and standards, notify the Architect-Engineer prior to the time of submitting a Bid. After entering into the Contract, the Contractor will be held liable to complete all work necessary to meet these requirements without extra cost to the Owner.

C. Should any conflict occur in, or between, the Drawings and Specifications, the Contractor is deemed to have based his Bid on the more expensive material, equipment, product, or work, unless he shall have asked for, and obtained, a written clarification or decision in regard to the conflict from the Architect-Engineer. The written decision, in the form of Addenda to the Contract, shall be obtained prior to submission of the Bid.

D. Work required by the Contract Documents, which exceed the minimum requirements of the governing codes, standards, and regulations shall be done as shown or specified

E. Include payments for fees, permits, inspections, and licensing required for the Mechanical Work under this Division.

F. Payment of assessments and charges levied by the serving utilities, relative to Mechanical Work, shall be paid by the Mechanical Contractor.

G. Arrange for required inspections as early as possible. When possible, have all inspections at the same time.

1.4 DRAWINGS AND MEASUREMENTS

A. Mechanical drawings are diagrammatic and indicate the general arrangement of systems and equipment, except when specifically, dimensioned or detailed. Plumbing, piping, and ductwork plans are intended to show size, capacity, approximate location, direction, and general relationship of one work phase to another, but not the exact detail or arrangement.

B. As the Mechanical drawings are of small scale, it is not possible to show all necessary offsets, fittings, and accessories. Examine General Construction, Mechanical, and Electrical Drawings and Specifications; obtain exact locations, measurements, levels, etc., at the site; arrange systems accordingly; and, at no additional expense to the Owner, furnish fittings, offsets, and accessories as required.

C. Mechanical equipment layout and service clearances are associated with the Basis of Design Equipment Requirements. If Contractor chooses to select equipment from other available manufacturers, the Contractor shall be responsible to verify all chosen manufacturer's service clearance are maintained. If the chosen equipment requires system or building design modifications to obtain these clearances, the Contractor shall be fully responsible for those modifications and associated costs.

1.05 SHOP DRAWING SUBMITTALS

A. Composite Drawings:
   1. The Contractor shall prepare composite Drawings and installation layouts when required to solve tight field conditions.
   2. Drawings shall consist of dimensioned plans and elevations and shall give complete information, particularly as to size and location of sleeves, inserts, attachments, openings, conduits, ducts, boxes, structural interferences, etc.

B. Product Data:
   1. The purpose of submittals by Contractor's is to demonstrate to the Architect-Engineer that the Contractor understands the design concept; and that his understanding is demonstrated by indicating the equipment and materials he intends to furnish and install, and the fabrication and installation methods he intends to use.
   2. The Contractor shall become acquainted with the content of the submittals prior to turning the material over to the Architect-Engineer. The Contractor shall review these submittals and make necessary corrections before merely forwarding them to the Architect-Engineer.
   3. Do not fabricate or order products or begin work which requires submittals until approval of submittal.
   4. Sequentially number submittals. Revised submittals should include original number and a sequential alphabetic suffix.
   5. Submit manufacturer's printed literature in original form. Any fading type of reproduction for example - a “second generation” facsimile will not be accepted.
   6. Each submittal shall be complete and in sufficient detail to allow ready determination of compliance with the contract requirements.
      a. Provide manufacturers catalog sheets, brochures, standard diagrams, schematics, schedules, performance charts, illustrations and other standard

descriptive data. Where printed literature describes items in addition to that item being submitted, the submitted item shall be clearly marked on the sheet and superfluous information shall be crossed out. Delete information which is not applicable to the Contract.

b. The Contractor shall supplement standard information with additional information applicable to this Contract, and indicate dimensions, clearances, performance characteristics, capacities, wiring and piping diagrams, and controls. Clearly delineate the following information:
   1) Applicable Contract Specification Section Numbers.
   2) Applicable Standards, such as ASTM or Federal specification numbers.
   3) Clearly mark each copy to identify pertinent product, or models. Show descriptive names of materials and equipment, classified item numbers, and locations at which materials or equipment are to be installed in the Work. Use the same reference identification as shown on Contract Drawings.
   4) Show physical dimensions, weights, and clearances required.
   5) Furnish performance curves for all pumps and fans
   6) Show performance data consisting of equipment capabilities, RPM, KW, pressure drops, design and operating points, pressures, temperatures, noise level curves, power characteristics and consumption; conforming as closely as possible to the test methods referenced in the plans and specifications.
   7) Show wiring or piping diagrams and controls.
   8) Identify any and all deviations from the Contract Drawings and specifications.

7. The Contractor’s stamp, initialed or signed, shall certify dimensional compatibility of the product(s) with the space in which it is intended to be used. Furthermore, it shall signify his review of the submittal(s) for compliance with Contract requirements.

C. Reviewed Submittals: The Architect-Engineer's review of submittals shall not be construed as a complete check but will indicate only that the general method of construction, materials, detailing and other information are satisfactory. Review will not relieve the Contractor of the responsibility for any error which may exist, as the Contractor is responsible for dimensions, the design of adequate connections and details, and the satisfactory construction of all work. After submittals have been reviewed by the Architect-Engineer, no resubmittal for the purpose of substituting materials or equipment will be considered unless accompanied by an explanation of why a substitution is necessary, and the Architect-Engineer is financially compensated for the additional review.

D. Deviations: For submittals which include proposed deviations requested by the Contractor, the proposed deviations from the contract requirements shall be clearly identified. The Contractor shall set forth in writing the reason for any deviations and annotate such deviations on the submittal.

1.5 1QUALITY OF WORK

A. All work shall be of the best quality free from defects in workmanship, materials, and performance.

1.6 DELIVERY AND RECEIVING

A. Arrange deliveries of products in accordance with construction progress schedules. Allow time for inspection prior to installation.

B. Coordinate deliveries to avoid conflict with work and conditions at site, work of other contractors, limitations on storage space, availability of personnel and handling equipment.

C. Deliver products in undamaged, dry condition, in original unopened containers or packaging with identifying labels intact and legible.

D. Clearly mark partial deliveries of component parts of equipment to identify equipment and contents to permit easy accumulation of parts and to facilitate assembly.

1.08 STORAGE, GENERAL

A. Store products, immediately on delivery, in accordance with manufacturer's instructions, with seals and labels intact. Protect until installed.

B. Arrange storage in a manner to provide access for maintenance of stored items and for inspection.

C. Protect products from dirt, including construction dust. Products left exposed to dirt or dust must be thoroughly cleaned to the satisfaction of the Engineer prior to installation.

1.09 ENCLOSED STORAGE

A. Store products, subject to damage by the elements, in substantial weather tight enclosures.

B. Maintain temperature and humidity within ranges stated in manufacturer’s instructions.

C. Provide humidity control and ventilation for sensitive products as required by manufacturer’s instructions.

D. Store unpacked and loose products on shelves, in bins, or in neat groups of like items.

1.7 3.10 EXTERIOR STORAGE

A. Provide substantial platforms, blocking, or skids, to support fabricated products above ground; slope to provide drainage. Protect products from soiling and staining.

B. For products subject to discoloration or deterioration from exposure to the elements, cover with impervious sheet material. Provide ventilation to avoid condensation.

C. Store loose granular materials on clean, solid surfaces such as pavement, or on rigid sheet material, to prevent mixing with foreign matter.

D. Provide surface drainage to prevent erosion and ponding of water.

1.8 SUBSTITUTIONS

A. Refer to front portion of the specifications.

B. The Owner shall be the sole and final judge as to the suitability of items substituted for those specified. Requests for substitutions shall be submitted no later than ten (10) days prior to the day of bid opening. If prior approval is not granted, equipment shall be furnished as specified or as shown on the plans.

C. The entire cost of all changes of any type due to substitutions for materials specified shall be borne by the Contractor at no extra cost to the Owner & shall reimburse other trades of additional cost due to substitution.

D. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals without separate written request, or when acceptance will require substantial revision of Contract Documents

CHANGE ORDERS

A. Refer to front portion of the specifications.

B. The Contractor shall, in no instance, commence work on, or provide materials for or make changes in, the work for this project which will require additional payment from the Owner to the Contractor until he has requested and obtained, in writing, either a signed written Change Order or a signed written notice to proceed with the extra work.

C. Each request for approval of additional work which is to require additional payment from the Owner, or in instances where credit is to be allowed to the Owner for omission of certain work or materials, shall be accompanied by a price quotation, including a complete cost breakdown of materials, labor, overhead and profit.

1.9 OPERATING AND MAINTENANCE MANUAL

D. Refer to front portion of the specifications and to each Section of Divisions 21, 22, and 23.

E. The Contractor shall furnish three (3) Operating and Maintenance Manuals to the Owner after all tests and adjustments have been completed. Final payment will not be made until this manual has been submitted and approved. In addition to the requirements of the front portion of these specifications, the manual shall include but not limited to:

1. Binder: All of the above described items shall be assembled in a three-ring binder with a hard cover and durable cloth or plastic finish.

2. Index: A complete index shall be included at the front of the manual.
3. Name, Address and Telephone of the Manufacturer and Local Representative: Include a list of all suppliers and representatives of products supplied on the project shall be included in the manual.
4. Valve List: A list of all valves with the number and function of each valve shall be included in the manual.
5. Shop Drawings: One copy of each approved shop drawing shall be included in the manual.
6. Manufacturers' Manuals and Parts Lists: Operating and maintenance manuals and parts lists furnished by equipment manufacturers shall be included in the manual.
7. Startup and Shutdown Procedures: A written description of the procedure for starting up and shutting down each mechanical system shall be included in the manual. This description shall include motors to start, valves to open, etc., in proper sequence and location of switches, starters, push buttons and valves.
8. Manufacturers Start-up of Equipment Documentation: Documents shall include date and time of start-up, name of authorized personnel who performed star-up, any required settings and notes concerning start-up shall be included in the manual.
9. State or City Tests, Approval, or Acceptance of Equipment and/or systems: This shall include date, time, name of authorized personnel and any other notes. Documentation of domestic water sterilization and equipment approved installation start-ups shall be included in the manual.
10. Reports: Include air and water balancing reports.

1.10 AS-BUILT DRAWINGS

F. Refer to front portion of the specifications.

G. This Contractor shall prepare as-built drawings for the various component portions of the mechanical installations. These drawings shall be furnished to the Owner after completion of the work. These drawings shall be prepared by marking up a set of contract drawings with colored pencils to show changes made during construction after the various installations have been completed.

1.11 GUARANTEE

H. Refer to front portion of the specifications.

I. The Contractor shall guarantee that all mechanical systems shall be free from defects in workmanship, materials and performance to specified capacities and that if such defects shall appear during a period of one year, or as specified in another section, from date of final acceptance, he will remedy such defects to the satisfaction of the Owner at no extra cost.

1.12 EXTRA MATERIALS

J. Furnish extra materials as described in each Division 21, 22, and 23 sections and items are packaged with protective covering for storage and identified with labels describing contents.

A. PART 1 – PRODUCTS (Not Applicable)

PART 2 – EXECUTION

2.1 MECHANICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:
1. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
2. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
3. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
4. Coordinate noisy or loud work to be completed during non-business working hours, weekends or during designated times from Owner.

END OF SECTION 210010

SECTION 21 05 17 - SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Grout.
4. Silicone Sealants.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

2.02 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Designed to form a hydrostatic seal of 20 psig (137 kPa) minimum.
2. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel or stainless steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.03 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.04 SILICONE SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C 920, Type S, Grade NS, Class 25, Use NT.

B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.

C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.

2. Using grout or silicone sealant, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior concrete partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.02 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.03 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.04 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade: Cast-iron wall sleeves with sleeve-seal system, or galvanized-steel-pipe sleeves with sleeve-seal system.

    a. Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

2. Exterior Concrete Walls below Grade: Cast-iron wall sleeves with sleeve-seal system, or galvanized-steel-pipe sleeves with sleeve-seal system.

    a. Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade: Cast-iron wall sleeves with sleeve-seal system, or galvanized-steel-pipe sleeves with sleeve-seal system.

    a. Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade: Galvanized-steel-pipe sleeves.

5. Interior Concrete Partitions:

    a. Piping Smaller than NPS 6 (DN 150): Galvanized-steel-pipe sleeves.
    b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 210517

SECTION 21 05 18 - ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 ESCUTCHEONS

A. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.

B. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

C. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished, chrome-plated finish and spring-clip fasteners.

D. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.

E. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.

2.02 FLOOR PLATES

A. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
g. Bare Piping in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated finish.

h. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
i. Chrome-Plated Piping: One-piece cast brass with polished, chrome-plated finish.
j. Insulated Piping: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
k. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated finish.
l. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated finish.
m. Bare Piping in Unfinished Service Spaces: One-piece cast brass with polished, chrome-plated finish.
n. Bare Piping in Equipment Rooms: One-piece cast brass with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor plate.

3.02 FIELD QUALITY CONTROL

A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION 210518

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SECTION 21 05 23- GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Two-piece ball valves with indicators.
2. Bronze butterfly valves with indicators.
3. Iron butterfly valves with indicators.
4. Check valves.
5. Bronze OS&Y gate valves.
6. Iron OS&Y gate valves.
7. NRS gate valves.
8. Indicator posts.
9. Trim and drain valves.

1.03 DEFINITIONS

A. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

B. NRS: Nonrising stem.

C. OS&Y: Outside screw and yoke.

D. SBR: Styrene-butadiene rubber.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and weld ends.
3. Set valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

D. Protect flanges and specialties from moisture and dirt.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

A. UL Listed: Valves shall be listed in UL's "Online Certifications Directory" under the headings listed below and shall bear UL mark:

1. Main Level: HAMV - Fire Main Equipment.

a. Level 1: HCBZ - Indicator Posts, Gate Valve.
b. Level 1: HLOT - Valves.

1) Level 3: HLUG - Ball Valves, System Control.
2) Level 3: HLXS - Butterfly Valves.
3) Level 3: HMER - Check Valves.
4) Level 3: HMRZ - Gate Valves.

2. Main Level: VDGT - Sprinkler System & Water Spray System Devices.

a. Level 1: VQGU - Valves, Trim and Drain.

B. FM Global Approved: Valves shall be listed in its "Approval Guide," under the headings listed below:

1. Automated Sprinkler Systems:

a. Indicator posts.
b. Valves.

1) Gate valves.
2) Check valves.

a) Single check valves.

3) Miscellaneous valves.

C. Source Limitations for Valves: Obtain valves for each valve type from single manufacturer.

D. ASME Compliance:

1. ASME B16.1 for flanges on iron valves.
2. ASME B1.20.1 for threads for threaded-end valves.
3. ASME B31.9 for building services piping valves.

E. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

F. NFPA Compliance: Comply with NFPA 24 for valves.

G. Valve Pressure Ratings: Not less than the minimum pressure rating indicated or higher as required by system pressures.

H. Valve Sizes: Same as upstream piping unless otherwise indicated.

I. Valve Actuator Types:

1. Worm-gear actuator with handwheel for quarter-turn valves, except for trim and drain valves.
2. Handwheel: For other than quarter-turn trim and drain valves.
3. Handlever: For quarter-turn trim and drain valves NPS 2 (DN 50) and smaller.

2.02 TWO-PIECE BALL VALVES WITH INDICATORS

A. Description:

1. UL 1091, except with ball instead of disc and FM Global standard for indicating valves (butterfly or ball type), Class Number 1112.
2. Minimum Pressure Rating: 175 psig (1200 kPa).
3. Body Design: Two piece.
4. Body Material: Forged brass or bronze.
5. Port Size: Full or standard.
6. Seats: PTFE.
7. Stem: Bronze or stainless steel.
8. Ball: Chrome-plated brass.
9. Actuator: Worm gear or traveling nut.
10. Supervisory Switch: Internal or external.
11. End Connections for Valves NPS 1 (DN 25) through NPS 2 (DN 50): Threaded ends.
12. End Connections for Valves NPS 2-1/2 (DN 65): Grooved ends.

2.03 BRONZE BUTTERFLY VALVES WITH INDICATORS

A. Description:

1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 1112.
2. Minimum: Pressure rating: 175 psig (1200 kPa).
3. Body Material: Bronze.

4. Seat Material: EPDM.
5. Stem Material: Bronze or stainless steel.
6. Disc: Bronze or stainless steel.
7. Actuator: Worm gear or traveling nut.
8. Supervisory Switch: Internal or external.
9. Ends Connections for Valves NPS 1 (DN 25) through NPS 2 (DN 50): Threaded ends.
10. Ends Connections for Valves NPS 2-1/2 (DN 65): Grooved ends.

2.04 IRON BUTTERFLY VALVES WITH INDICATORS

A. Description:

1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 112.
2. Minimum Pressure Rating: 175 psig (1200 kPa).
3. Body Material: Cast or ductile iron.
4. Seat Material: EPDM.
5. Stem: Stainless steel.
6. Disc: Ductile iron, nickel plated.
7. Actuator: Worm gear or traveling nut.
8. Supervisory Switch: Internal or external.
9. Body Design: Lug, wafer, or grooved-end connections.

2.05 CHECK VALVES

A. Description:

1. Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.
2. Minimum Pressure Rating: 175 psig (1200 kPa).
3. Type: Single swing check.
4. Body Material: Cast iron, ductile iron, or bronze.
5. Clapper: Bronze, ductile iron, or stainless steel.
6. Clapper Seat: Brass, bronze, or stainless steel.
7. Hinge Shaft: Bronze or stainless steel.
8. Hinge Spring: Stainless steel.
9. End Connections: Flanged, grooved, or threaded.

2.06 BRONZE OS&Y GATE VALVES

A. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig (1200 kPa).
3. Body and Bonnet Material: Bronze or brass.
4. Wedge: One-piece bronze or brass.

5. Wedge Seat: Bronze.
6. Stem: Bronze or brass.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Threaded.

2.07 IRON OS&Y GATE VALVES

A. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig (1200 kPa).
3. Body and Bonnet Material: Cast or ductile iron.
4. Wedge: Cast or ductile iron, or bronze.
5. Wedge Seat: Cast or ductile iron, or bronze.
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Flanged or grooved.

2.08 NRS GATE VALVES

A. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig (1200 kPa).
3. Body and Bonnet Material: Cast or ductile iron.
4. Wedge: Cast or ductile iron.
5. Wedge Seat: Cast or ductile iron, or bronze.
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Flanged or grooved.

2.09 INDICATOR POSTS

A. Description:

1. Standard: UL 789 and FM Global standard for indicator posts.
2. Base Barrel Material: Cast or ductile iron.
3. Cap: Cast or ductile iron.
4. Operation: Wrench.

2.010 TRIM AND DRAIN VALVES

A. Ball Valves:

1. Description:

a. Pressure Rating: 175 psig (1200 kPa).
b. Body Design: Two piece.
c. Body Material: Forged brass or bronze.
d. Port size: Full or standard.
e. Seats: PTFE.
f. Stem: Bronze or stainless steel.
g. Ball: Chrome-plated brass.
h. Actuator: Handlever.
i. End Connections for Valves NPS 1 (DN 25) through NPS 2-1/2 (DN 65): Threaded ends.
j. End Connections for Valves NPS 1-1/4 and NPS 2-1/2 (DN 32 and DN 65): Grooved ends.

B. Angle Valves:

1. Description:

a. Pressure Rating: 175 psig (1200 kPa).
b. Body Material: Brass or bronze.
c. Ends: Threaded.
d. Stem: Bronze.
e. Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron, bronze, or aluminum.

C. Globe Valves:

1. Description:

a. Pressure Rating: 175 psig (1200 kPa).
b. Body Material: Bronze with integral seat and screw-in bonnet.
c. Ends: Threaded.
d. Stem: Bronze.
e. Disc Holder and Nut: Bronze.
f. Disc Seat: Nitrile.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.02 GENERAL REQUIREMENTS FOR VALVE INSTALLATION

A. Comply with requirements in the following Sections for specific valve installation requirements and applications:

1. Section 211100 "Facility Fire-Suppression Water-Service Piping" for application of valves in fire-suppression water-service piping outside the building.
2. Section 211200 "Fire-Suppression Standpipes" for application of valves in fire-suppression standpipes.
3. Section 211313 "Wet-Pipe Sprinkler Systems" for application of valves in wet-pipe, fire-suppression sprinkler systems.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.

E. Install valves in horizontal piping with stem at or above the pipe center.

F. Install valves in position to allow full stem movement.

G. Install valve tags. Comply with requirements in Section 210553 "Identification for Fire-Suppression Piping and Equipment" for valve tags and schedules and signs on surfaces concealing valves; and the NFPA standard applying to the piping system in which valves

are installed. Install permanent identification signs indicating the portion of system controlled by each valve.

H. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections.

I. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

END OF SECTION 210523

SECTION 21 11 00 - FACILITY FIRE-SUPPRESSION WATER-SERVICE PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes fire-suppression water-service piping and related components outside the building and service entrance piping through floor or wall into the building and the following:

1. Pipes and fittings.

B. Related Requirements:

1. Section 211119 "Fire-Department Connections" for exposed-, flush-, and yard-type, fire-department connections.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.04 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with requirements of utility company supplying the water. Include tapping of water mains and backflow prevention.
2. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

C. Comply with FM Global's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

D. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-suppression water-service piping.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

B. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

PART 2 - PRODUCTS

2.01 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end.

B. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

1. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.02 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105.

B. Material: Linear low-density PE film of 0.008-inch (0.20-mm) minimum thickness or high-density, cross-laminated PE film of 0.004-inch (0.10-mm) minimum thickness.

C. Form: Sheet or tube.

D. Color: Black or natural.

PART 3 - EXECUTION

3.01 EARTHWORK

A. Comply with excavating, trenching, and backfilling requirements in Section 312000 "Earth Moving."

3.02 PIPING INSTALLATION

A. Water-Main Connection: Arrange with water utility company for tap of size and in location indicated in water main.

B. Water-Main Connection: Tap water main according to requirements of water utility company and of size and in location indicated.

C. Make connections larger than NPS 2 (DN 50) with tapping machine according to the following:

1. Install tapping sleeve and tapping valve according to MSS SP-60.
2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.

D. Comply with NFPA 24 for fire-service-main piping materials and installation.

E. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.

1. Install encasement for piping according to ASTM A 674 or AWWA C105.

F. Bury piping with depth of cover over top at least 30 inches (750 mm), with top at least 12 inches (300 mm) below level of maximum frost penetration, and according to the following:

1. Under Driveways: With at least 36 inches (910 mm) of cover over top.
2. In Loose Gravelly Soil and Rock: With at least 12 inches (300 mm) of additional cover.

G. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.

H. Extend fire-suppression water-service piping and connect to water-supply source and building fire-suppression water-service piping systems at locations and pipe sizes indicated.

1. Terminate fire-suppression water-service piping within the building at the floor slab until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building's fire-suppression water-service piping systems when those systems are installed.

I. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

J. Comply with requirements in Section 211200 "Fire-Suppression Standpipes," Section 211313 "Wet-Pipe Sprinkler Systems," for fire-suppression-water piping inside the building.

K. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

L. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

3.03 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure rating same as or higher than systems pressure rating for aboveground applications unless otherwise indicated.

B. Ream ends of tubes and remove burrs.

C. Remove scale, slag, dirt, and debris from outside and inside of pipes, tubes, and fittings before assembly.

D. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.

E. Do not use flanges or unions for underground piping.

3.04 ANCHORAGE INSTALLATION

A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:

1. Concrete thrust blocks.
2. Locking mechanical joints.
3. Set-screw mechanical retainer glands.
4. Bolted flanged joints.
5. Heat-fused joints.
6. Pipe clamps and tie rods.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches in fire-suppression water-service piping according to NFPA 24 and the following:

1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.05 CONNECTIONS

A. Connect fire-suppression water-service piping to interior fire-suppression piping.

3.06 FIELD QUALITY CONTROL

A. Use test procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described below.

B. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

C. Hydrostatic Tests: Test at not less than one-and-one-half times the working pressure for two hours.

1. Increase pressure in 50-psig (350-kPa) increments and inspect each joint between increments. Hold at test pressure for one hour; decrease to zero psig (zero kPa). Slowly increase again to test pressure and hold for one more hour. Maximum allowable leakage is 2 quarts (1.89 L) per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

D. Prepare test and inspection reports.

3.07 CLEANING

A. Clean fire-suppression water-service piping as follows:

1. Purge new piping systems and parts of existing systems that have been altered, extended, or repaired before use.
2. Use purging procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:

    a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow it to stand for 24 hours.
    b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow it to stand for three hours.
    c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
    d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports of purging activities.

3.08 PIPING SCHEDULE

A. Underground and underslab fire-suppression water-service piping shall be the following:

1. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile- or gray-iron, standard-pattern or ductile-iron, compact-pattern fittings; glands, gaskets, and bolts; and gasketed joints.

END OF SECTION 211100

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SECTION 21 11 19 - FIRE-DEPARTMENT CONNECTIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Exposed-type fire-department connections.
2. Flush-type fire-department connections.
3. Yard-type fire-department connections.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each fire-department connection.

PART 2 - PRODUCTS

2.01 EXPOSED-TYPE FIRE-DEPARTMENT CONNECTION

A. Standard: UL 405.

B. Type: Exposed, projecting, for wall mounting.

C. Pressure Rating: 175 psig (1200 kPa) minimum.

D. Body Material: Corrosion-resistant metal.

E. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.

F. Caps: Brass, lugged type, with gasket and chain.

G. Escutcheon Plate: Round, brass, wall type.

H. Outlet: Back, with pipe threads.

I. Number of Inlets: One (1) Storz Type

J. Escutcheon Plate Marking: Similar to "AUTO SPKR." or "AUTO SPKR & STANDPIPE."

K. Finish: Polished chrome plated.

L. Outlet Size: NPS 4 (DN 100).

2.02 FLUSH-TYPE FIRE-DEPARTMENT CONNECTION

A. Standard: UL 405.

B. Type: Flush, for wall mounting.

C. Pressure Rating: 175 psig (1200 kPa) minimum.

D. Body Material: Corrosion-resistant metal.

E. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.

F. Caps: Brass, lugged type, with gasket and chain.

G. Escutcheon Plate: Rectangular, brass, wall type.

H. Outlet: With pipe threads.

I. Body Style: Horizontal.

J. Number of Inlets: Two.

K. Escutcheon Plate Marking: Similar to "AUTO SPKR." or "AUTO SPKR & STANDPIPE."

L. Finish: Polished chrome plated.

M. Outlet Size: NPS 4 (DN 100).

2.03 YARD-TYPE FIRE-DEPARTMENT CONNECTION

A. Standard: UL 405.

B. Type: Exposed, freestanding.

C. Pressure Rating: 175 psig (1200 kPa) minimum.

D. Body Material: Corrosion-resistant metal.

E. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.

F. Caps: Brass, lugged type, with gasket and chain.

G. Escutcheon Plate: Round, brass, floor type.

H. Outlet: Bottom, with pipe threads.

I. Number of Inlets: Two.

J. Sleeve: Brass.

K. Sleeve Height: 18 inches (460 mm).

L. Escutcheon Plate Marking: Similar to "AUTO SPKR." or "AUTO SPKR & STANDPIPE."

M. Finish, Including Sleeve: Polished chrome plated.

N. Outlet Size: NPS 4 (DN 100).

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fire-department connections.

B. Examine roughing-in for fire-suppression standpipe system to verify actual locations of piping connections before fire-department connection installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install wall-type fire-department connections.

B. Install yard-type fire-department connections in concrete slab support. Comply with requirements for concrete in Section 033000 "Cast-in-Place Concrete."

C. Install automatic (ball-drip) drain valve at each check valve for fire-department connection.

END OF SECTION 211119

SECTION 21 12 00 - FIRE-SUPPRESSION STANDPIPES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Fire-protection specialty valves.
3. Hose connections.
4. Alarm devices.
5. Manual control stations.
6. Control panels.
7. Pressure gages.

B. Related Requirements:

1. Section 210523 "General-Duty Valves for Water-Based Fire-Suppression Piping."
2. Section 211119 "Fire-Department Connections" for exposed wall-mounted and yard fire hydrants.
3. Section 211213 "Fire-Suppression Hoses and Nozzles" for rack-type hose stations, reel-type hose stations, and monitors.
4. Section 211313 "Wet-Pipe Sprinkler Systems" for wet-pipe sprinkler piping.
5. Section 211316 "Dry-Pipe Sprinkler Systems" for dry-pipe sprinkler piping.
6. Section 284621.13 "Conventional Fire-Alarm Systems" for connections to alarm devices.

1.03 DEFINITIONS

A. High-Pressure Standpipe Piping: Fire-suppression standpipe piping designed to operate at working pressure higher than standard 175 psig (1200 kPa), but not higher than 250 psig (1725 kPa).

B. Standard-Pressure Standpipe Piping: Fire-suppression standpipe piping designed to operate at working pressure 175 psig (1200 kPa) maximum.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For fire-suppression standpipes.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: For standpipe systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Fire-suppression standpipes, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Domestic water piping.
2. Compressed-air piping.
3. HVAC hydronic piping.
4. Nitrogen piping.

B. Qualification Data: For Installer.

C. Approved Standpipe Drawings: Working plans, prepared according to NFPA 14, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

D. Welding certificates.

E. Fire-hydrant flow test report.

F. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 14. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."

G. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-suppression standpipes specialties to include in emergency, operation, and maintenance manuals.

1.07 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing fire-suppression standpipes and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. NFPA Standards: Fire-suppression standpipe equipment, specialties, accessories, installation, and testing shall comply with NFPA 14.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTIONS

A. Automatic Wet-Type, Class I Standpipe System: Includes NPS 2-1/2 (DN 65) hose connections. Has open water-supply valve with pressure maintained and is capable of supplying water demand.

B. Automatic Wet-Type, Class II Standpipe System: Includes NPS 1-1/2 (DN 40) hose stations. Has open water-supply valve with pressure maintained and is capable of supplying water demand.

C. Automatic Wet-Type, Class III Standpipe System: Includes NPS 1-1/2 (DN 40) hose stations and NPS 2-1/2 (DN 65) hose connections. Has open water-supply valve with pressure maintained and is capable of supplying water demand.

D. Automatic Dry-Type, Class I Standpipe System: Includes NPS 2-1/2 (DN 65) hose connections. Has open water-supply valve and dry-pipe valve with standpipes containing compressed air or nitrogen. Opening fire-hose valve releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into standpipes.

E. Automatic Dry-Type, Class II Standpipe System: Includes NPS 1-1/2 (DN 40) hose stations. Has open water-supply valve and dry-pipe valve with standpipes containing compressed air or nitrogen. Opening fire-hose valve releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into standpipes.

F. Automatic Dry-Type, Class III Standpipe System: Includes NPS 1-1/2 (DN 40) hose stations and NPS 2-1/2 (DN 65) hose connections. Has open water-supply valve and dry-pipe valve with standpipes containing compressed air or nitrogen. Opening fire-hose valve releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into standpipes.

G. Semiautomatic Dry-Type, Class I Standpipe System: Includes NPS 2-1/2 (DN 65) hose connections. Has open water-supply valve and deluge valve with standpipes containing air. Actuation of detection device permits water pressure to open deluge valve. Water then flows into standpipes.

H. Semiautomatic Dry-Type, Class II Standpipe System: Includes NPS 1-1/2 (DN 40) hose stations. Has open water-supply valve and deluge valve with standpipes containing air. Actuation of detection device permits water pressure to open deluge valve. Water then flows into standpipes.

I. Semiautomatic Dry-Type, Class III Standpipe System: Includes NPS 1-1/2 (DN 40) hose stations and NPS 2-1/2 (DN 65) hose connections. Has open water-supply valve and deluge valve with standpipes containing air. Actuation of detection device permits water pressure to open deluge valve. Water then flows into standpipes.

J. Manual Wet-Type, Class I Standpipe System: Includes NPS 2-1/2 (DN 65) hose connections. Has small water supply to maintain water in standpipes. Piping is wet, but water must be pumped into standpipes to satisfy demand.

K. Manual Dry-Type, Class I Standpipe System: Includes NPS 2-1/2 (DN 65) hose connections. Does not have permanent water supply. Piping is dry. Water must be pumped into standpipes to satisfy demand.

2.02 PERFORMANCE REQUIREMENTS

A. Standard-Pressure, Fire-Suppression Standpipe System Component: Listed for 175-psig (1200-kPa) minimum working pressure.

B. High-Pressure, Fire-Suppression Standpipe System Component: Listed for 250-psig (1725-kPa) minimum working pressure.

C. Delegated Design: Design fire-suppression standpipes, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

D. Fire-suppression standpipe design shall be approved by authorities having jurisdiction.

1. Minimum residual pressure at each hose-connection outlet is as follows:

a. NPS 1-1/2 (DN 40) Hose Connections: 65 psig (450 kPa).
b. NPS 2-1/2 (DN 65) Hose Connections: 100 psig (690 kPa).

E. Seismic Performance: Fire-suppression standpipes shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

2.03 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials and for joining methods for specific services, service locations, and pipe sizes.

2.04 BLACK STEEL PIPE AND ASSOCIATED FITTINGS

A. Schedule 40: ASTM A53/A53M, Type E, Grade B; with factory- or field-formed ends to accommodate joining method.

B. Schedule 40: ASTM A135/A135M, Grade A; with factory- or field-formed ends to accommodate joining method.

C. Schedule 40: ASTM A795/A795M, Type E, Grade A; with factory- or field-formed ends to accommodate joining method.

D. Schedule 30: ASTM A53/A53M, Type E, Grade B; with factory- or field-formed ends to accommodate joining method.

E. Schedule 30: ASTM A135/A135M, Grade A; with factory- or field-formed ends to accommodate joining method.

F. Schedule 30: ASTM A795/A795M, Type E, Grade A; with factory- or field-formed ends to accommodate joining method.

G. Thinwall: ASTM A53/A53M, Type E; with wall thickness less than Schedule 30 and equal to or greater than Schedule 10; and with factory- or field-formed ends to accommodate joining method.

H. Thinwall: ASTM A135/A135M, Grade A; with wall thickness less than Schedule 30 and equal to or greater than Schedule 10; and with factory- or field-formed ends to accommodate joining method.

I. Thinwall: ASTM A795/A795M, Type E, Grade A; with wall thickness less than Schedule 30 and equal to or greater than Schedule 10; and with factory- or field-formed ends to accommodate joining method.

J. Schedule 10: ASTM A135/A135M or ASTM A795/A795M, Schedule 10 in NPS 5 (DN 125) and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10 (DN 150 to DN 250), plain end.

K. Uncoated, Steel Couplings: ASTM A865/A865M, threaded.

L. Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

M. Malleable- or Ductile-Iron Unions: UL 860.

N. Cast-Iron Flanges: ASME B16.1, Class 125.

O. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

P. Steel Welding Fittings: ASTM A234/A234M and ASME B16.9.

Q. Grooved-Joint, Steel-Pipe Appurtenances:
1. Pressure Rating: 175 psig (1200 kPa) minimum.
2. Galvanized, Grooved-End Fittings for Steel Piping: ASTM A47/A47M, malleable-iron casting or ASTM A536, ductile-iron casting; with dimensions matching steel pipe.
3. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.05 GALVANIZED-STEEL PIPE AND ASSOCIATED FITTINGS

A. Schedule 40: ASTM A53/A53M, Type E, Grade B; with factory- or field-formed ends to accommodate joining method.

B. Schedule 40: ASTM A135/A135M, Grade A; with factory- or field-formed ends to accommodate joining method.

C. Schedule 40: ASTM A795/A795M, Type E, Grade A; with factory- or field-formed ends to accommodate joining method.

D. Galvanized-Steel Pipe Nipples: ASTM A733, made of ASTM A53/A53M or ASTM A106/A106M, Standard Weight, seamless steel pipe with threaded ends.

E. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

F. Malleable-Iron Unions:

1. ASME B16.39, Class 150.
2. Hexagonal-stock body.
3. Ball-and-socket, metal-to-metal, bronze seating surface.
4. Threaded ends.

G. Flanges: ASME B16.1, Class 125, cast iron.

H. Appurtenances for Grooved-End, Galvanized-Steel Pipe:
1. Fittings for Grooved-End, Galvanized-Steel Pipe: Galvanized, ASTM A47/A47M, malleable-iron casting; ASTM A106/A106M, steel pipe; or ASTM A536, ductile-iron casting; with dimensions matching steel pipe.
2. Fittings for Grooved-End, Galvanized-Steel Pipe:

a. AWWA C606 for steel-pipe dimensions.
b. Ferrous housing sections.
c. EPDM-rubber gaskets suitable for hot and cold water.
d. Bolts and nuts.
e. Minimum Pressure Rating:

1) NPS 8 (DN 200) and Smaller: 600 psig (4137 kPa)
2) NPS 10 and NPS 12 (DN 250 to DN 300): 400 psig (2758 kPa).
3) NPS 14 to NPS 24 (DN 350 to DN 600): 250 psig (1725 kPa).

2.06 COPPER TUBE AND ASSOCIATED FITTINGS

A. Hard Copper Tube: ASTM B88, Type L (ASTM B88M, Type B) water tube, drawn temper.

B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.

D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

E. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

F. Grooved-Joint, Copper-Tube Appurtenances:
1. Grooved-End, Copper Fittings: ASTM B75 (ASTM B75M), copper tube or ASTM B584, bronze castings.
2. Grooved-End-Tube Couplings: To fit copper tube dimensions, with design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gasket suitable for hot and cold water, and bolts and nuts.

2.07 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free.

1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

D. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.08 SPECIALTY VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or FM Global's "Approval Guide."
2. Pressure Rating:

    a. Standard-Pressure Piping Specialty Valves: 175 psig (1200 kPa) minimum.
    b. High-Pressure Piping Specialty Valves: 250 psig (1725 kPa) minimum.

3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Alarm Valves:
1. Standard: UL 193.
2. Design: For horizontal or vertical installation.
3. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.
4. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
5. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

C. Pressure-Reducing Valves:
1. UL 668 hose valve, with integral UL 1468 reducing device.
2. Pressure Rating: 300 psig (2070 kPa) minimum.
3. Material: Brass or bronze.
4. Inlet: Female pipe threads.
5. Outlet: Threaded with or without adapter having male hose threads.
6. Pattern: Angle or gate.
7. Finish: Polished chrome-plated.

D. Automatic (Ball Drip) Drain Valves:
1. Standard: UL 1726.
2. Pressure Rating: 175 psig (1200 kPa) minimum.
3. Type: Automatic draining, ball check.
4. Size: NPS 3/4 (DN 20).
5. End Connections: Threaded.

2.09 HOSE CONNECTIONS

A. Adjustable-Valve Hose Connections:
1. Standard: UL 668 hose valve, with integral UL 1468 reducing or restricting pressure-control device, for connecting fire hose.
2. Pressure Rating: 300 psig (2070 kPa) minimum.
3. Material: Brass or bronze.
4. Size: NPS 1-1/2 or NPS 2-1/2 (DN 40 or DN 65), as indicated.
5. Inlet: Female pipe threads.
6. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads according to NFPA 1963 and matching local fire-department threads.
7. Pattern: Angle or gate.
8. Pressure-Control Device Type: Pressure reducing.
9. Finish: Polished chrome-plated.

B. Nonadjustable-Valve Hose Connections:
1. Standard: UL 668 hose valve for connecting fire hose.
2. Pressure Rating: 300 psig (2070 kPa) minimum.
3. Material: Brass or bronze.
4. Size: NPS 1-1/2 or NPS 2-1/2 (DN 40 or DN 65), as indicated.
5. Inlet: Female pipe threads.
6. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads according to NFPA 1963 and matching local fire-department threads.
7. Pattern: Angle or gate.
8. Finish: Polished chrome-plated.

2.010 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Motor-Operated Alarm:
1. Standard: UL 753.
2. Type: Mechanically operated, with pelton wheel.
3. Alarm Gong: Cast aluminum with red-enamel factory finish.
4. Size: 10-inch (250-mm) diameter.
5. Components: Shaft length, bearings, and sleeve to suit wall construction.
6. Inlet: NPS 3/4 (DN 20).
7. Outlet: NPS 1 (DN 25) drain connection.

C. Electrically Operated Alarm Bell:
1. Standard: UL 464.
2. Type: Vibrating, metal alarm bell.
3. Size: 6-inch (150-mm) minimum diameter.
4. Finish: Red-enamel factory finish, suitable for outdoor use.

D. Water-Flow Indicators:
1. Standard: UL 346.
2. Water-Flow Detector: Electrically supervised.
3. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
4. Type: Paddle operated.
5. Pressure Rating: 250 psig (1725 kPa).
6. Design Installation: Horizontal or vertical.

E. Pressure Switches:
1. Standard: UL 346.
2. Type: Electrically supervised water-flow switch with retard feature.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design Operation: Rising pressure signals water flow.

F. Valve Supervisory Switches:
1. Standard: UL 346.

2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled valve is in other than fully open position.

G. Indicator-Post Supervisory Switches:
1. Standard: UL 346.
2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled indicator-post valve is in other than fully open position.

2.011 MANUAL CONTROL STATIONS

A. Description: UL listed or FM Global approved, hydraulic operation, with union, NPS 1/2 (DN 15) pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

2.012 CONTROL PANELS

A. Description: Single-area, two-area, or single-area cross-zoned control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves. Panels contain power supply; battery charger; standby batteries; field-wiring terminal strip; electrically supervised solenoid valves and polarized fire-alarm bell; lamp test facility; single-pole, double-throw auxiliary alarm contacts; and rectifier.

1. Panels: UL listed and FM Global approved when used with thermal detectors and Class A detector circuit wiring. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.
2. Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.
3. Manual Control Stations: Hydraulic operation, with union, NPS 1/2 (DN 15) pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

2.013 PRESSURE GAGES

A. Standard: UL 393.

B. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.

C. Pressure Gage Range: Zero to 250 psig (Zero to 1725 kPa) minimum.

D. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

E. Air System Piping Gage: Include "AIR" or "AIR/WATER" label on dial face.

PART 3 - EXECUTION

3.01 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 14 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.02 EXAMINATION

A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.

B. Examine walls and partitions for suitable thickness, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 SERVICE-ENTRANCE PIPING

A. Connect fire-suppression standpipe piping to water-service piping at service entrance into building. Comply with requirements for exterior piping in Section 211100 "Facility Fire-Suppression Water-Service Piping."

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories at connection to fire-suppression water-service piping. Comply with requirements for backflow preventers in Section 211100 "Facility Fire-Suppression Water-Service Piping."

C. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.04 WATER-SUPPLY CONNECTIONS

A. Connect fire-suppression standpipe piping to building's interior water-distribution piping. Comply with requirements for interior piping in Section 221116 "Domestic Water Piping."

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories at connection to water-distribution piping. Comply with requirements for backflow preventers in Section 221119 "Domestic Water Piping Specialties."

C. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

3.05 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

B. Piping Standard: Comply with requirements in NFPA 14 for installation of fire-suppression standpipe piping.

C. Install seismic restraints on piping. Comply with requirements in NFPA 13 for seismic-restraint device materials and installation.

D. Install listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install drain valves on standpipes. Extend drain piping to outside of building.

F. Install automatic (ball drip) drain valves to drain piping between fire-department connections and check valves. Drain to floor drain or outside building.

G. Install alarm devices in piping systems.

H. Install hangers and supports for standpipe system piping according to NFPA 14. Comply with requirements in NFPA 13 for hanger materials.

I. Install pressure gages on riser or feed main and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 (DN 8) and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.

J. Drain dry-type standpipe system piping.

K. Pressurize and check dry-type standpipe system piping and air-pressure maintenance devices.

L. Fill wet-type standpipe system piping with water.

M. Install electric heating cables and pipe insulation on wet-type fire-suppression standpipe piping in areas subject to freezing. Comply with requirements for heating cables in Section 210533 "Heat Tracing for Fire-Suppression Piping" and for piping insulation in Section 210700 "Fire-Suppression Systems Insulation."

N. Connect compressed-air or nitrogen supply to dry-pipe sprinkler piping.

O. Connect air compressor to the following piping and wiring:

1. Pressure gages and controls.
2. Electrical power system.

3. Fire-alarm devices, including low-pressure alarm.

P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

3.06 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.

D. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

I. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

J. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to "Quality Assurance" Article.

1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

K. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

L. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

M. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.07 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 14 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Specialty Valves:

1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
2. Alarm Valves: Install bypass check valve and retarding chamber drain-line connection.

3.08 HOSE-CONNECTION INSTALLATION

A. Install hose connections adjacent to standpipes.

B. Install freestanding hose connections for access and minimum passage restriction.

C. Install NPS 1-1/2 (DN 40) hose-connection valves with flow-restricting device.

D. Install NPS 2-1/2 (DN 65) hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 (DN 65 by DN 40) reducer adapter and flow-restricting device.

E. Install wall-mounted-type hose connections in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet.

Install valves at angle required for connection of fire hose. Comply with requirements for cabinets in Section 104413 "Fire Protection Cabinets."

3.09 HOSE-STATION INSTALLATION

A. Install freestanding hose stations for access and minimum passage restriction.

B. Install NPS 1-1/2 (DN 40) hose-station valves with flow-restricting device unless otherwise indicated.

C. Install NPS 2-1/2 (DN 65) hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 (DN 65 by DN 40) reducer adapter and flow-restricting device unless otherwise indicated.

D. Install freestanding hose stations with support or bracket attached to standpipe.

E. Install wall-mounted, rack hose stations in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose. Comply with requirements for cabinets in Section 104413 "Fire Protection Cabinets."

F. Install hose-reel hose stations on wall with bracket.

3.010 FIRE-DEPARTMENT CONNECTION INSTALLATION

A. Install wall-type fire-department connections.

B. Install yard-type fire-department connections in concrete slab support. Comply with requirements for concrete in Section 033000 "Cast-in-Place Concrete."

1. Install protective pipe bollards around each fire-department connection. Comply with requirements for bollards in Section 055000 "Metal Fabrications."

C. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

3.011 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 14.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.012 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect standpipe systems according to NFPA 14, "System Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Start and run air compressors.
6. Coordinate with fire-alarm tests. Operate as required.
7. Coordinate with fire-pump tests. Operate as required.
8. Verify that equipment hose threads are same as local fire-department equipment.

C. Fire-suppression standpipe system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.013 DEMONSTRATION

A. Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.014 PIPING SCHEDULE

A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends; cast-iron threaded fittings; and threaded joints.

B. Standard-pressure, wet-type fire-suppression standpipe piping, NPS 4 (DN 100) and smaller, shall be one of the following:

1. Schedule 40 or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Schedule 40 or thinwall, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
3. Schedule 40 or Schedule 30, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
4. Schedule 40 or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
5. Schedule 40 or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
6. Thinwall Schedule 10, or lightwall black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
7. Thinwall Schedule 10, or lightwall black-steel pipe with plain ends; welding fittings; and welded joints.

8. Type L (Type B), hard copper tube with plain ends; cast- or wrought-copper solder-joint fittings; and brazed joints.
9. Type L (Type B), hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.

C. Standard-pressure, wet-type fire-suppression standpipe piping, NPS 5 to NPS 8 (DN 125 to DN 200), shall be one of the following:

1. Schedule 40 or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Schedule 40 or thinwall, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
3. Schedule 40 or Schedule 30, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
4. Schedule 40 or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
5. Schedule 40 or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
6. Thinwall Schedule 10, or lightwall black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
7. Thinwall Schedule 10, or lightwall black-steel pipe with plain ends; welding fittings; and welded joints.
8. Type L (Type B), hard copper tube with plain ends; cast- or wrought-copper solder-joint fittings; and brazed joints.
9. Type L (Type B), hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.

END OF SECTION 211200

SECTION 21 13 13 - WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Cover system for sprinkler piping.
3. Specialty valves.
4. Sprinklers.
5. Alarm devices.
6. Manual control stations.
7. Control panels.
8. Pressure gages.

B. Related Requirements:

1. Section 211119 "Fire Department Connections" for exposed-, flush-, and yard-type fire department connections.
2. Section 230523 "General-Duty Valves for Water-Based Fire-Suppression Piping" for ball, butterfly, check, gate, post-indicator, and trim and drain valves.

1.03 DEFINITIONS

A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175-psig (1200-kPa) maximum.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For wet-pipe sprinkler systems.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: For wet-pipe sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer or NICET Level IV responsible for their preparation.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Domestic water piping.
2. Compressed air piping.
3. HVAC hydronic piping.
4. Items penetrating finished ceiling include the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.

B. Qualification Data: For qualified Installer and professional engineer or NICET Level IV.

C. Design Data:

1. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

D. Welding certificates.

E. Field Test Reports:

1. Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
2. Fire-hydrant flow test report.

F. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1.07 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

1.08 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding Qualifications: Qualify procedures and operators according to 2010 ASME Boiler and Pressure Vessel Code.

1.09 FIELD CONDITIONS

A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of sprinkler service.
2. Do not proceed with interruption of sprinkler service without Owner's written permission.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13.
2. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

B. Standard-Pressure Piping System Component: Listed for 175-psig (1200-kPa) minimum working pressure.

C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design wet-pipe sprinkler systems.

1. Sprinkler system design shall be approved by authorities having jurisdiction.

    a. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
    b. Sprinkler Occupancy Hazard Classifications:

        1) Automobile Parking Areas: Ordinary Hazard, Group 1.
        2) Building Service Areas: Ordinary Hazard, Group 1.
        3) Churches: Light Hazard.
        4) Electrical Equipment Rooms: Ordinary Hazard, Group 1.
        5) Dry Cleaners: Ordinary Hazard, Group 2.
        6) General Storage Areas: Ordinary Hazard, Group 1.
        7) Laundries: Ordinary Hazard, Group 1.
        8) Libraries except Stack Areas: Light Hazard.
        9) Library Stack Areas: Ordinary Hazard, Group 2.
        10) Machine Shops: Ordinary Hazard, Group 2.
        11) Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
        12) Office and Public Areas: Light Hazard.
        13) Plastics Processing Areas: Extra Hazard, Group 2.
        14) Printing Plants: Extra Hazard, Group 1.
        15) Repair Garages: Ordinary Hazard, Group 2.
        16) Residential Living Areas: Light Hazard.
        17) Restaurant Service Areas: Ordinary Hazard, Group 1.
        18) Solvent Cleaning Areas: Extra Hazard, Group 2.
        19) Upholstering Plants: Extra Hazard, Group 1.
        20) Areas not listed here: Per NFPA 13.

2. Minimum Density for Automatic-Sprinkler Piping Design:

    a. Residential (Dwelling) Occupancy: [0.05 gpm over 400-sq. ft. area.
    b. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
    c. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
    d. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.
    e. Extra-Hazard, Group 1 Occupancy: 0.30 gpm over 2500-sq. ft. area.
    f. Extra-Hazard, Group 2 Occupancy: 0.40 gpm over 2500-sq. ft. area.
    g. Special Occupancy Hazard: As determined by authorities having jurisdiction.

3. Minimum Density for Deluge-Sprinkler Piping Design:

    a. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over entire area.
    b. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over entire area.
    c. Extra-Hazard, Group 1 Occupancy: 0.30 gpm over entire area.
    d. Extra-Hazard, Group 2 Occupancy: 0.40 gpm over entire area.
    e. Special Occupancy Hazard: As determined by authorities having jurisdiction.

4. Maximum Protection Area per Sprinkler: According to UL listing.

2.02 STEEL PIPE AND FITTINGS

A. Standard-Weight, Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

B. Schedule 10, Black-Steel Pipe: ASTM A 135/A 135M or ASTM A 795/A 795M, Schedule 10 in NPS 5 (DN 125) and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10 (DN 150 to DN 250), plain end.

C. Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.

D. Galvanized- and Uncoated-Steel Couplings: ASTM A 865/A 865M, threaded.

E. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

F. Malleable- or Ductile-Iron Unions: UL 860.

G. Cast-Iron Flanges: ASME 16.1, Class 125.

H. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick.

   a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
   b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.

2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.

I. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.

1. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

J. Grooved-Joint, Steel-Pipe Appurtenances:

1. Pressure Rating: 175-psig (1200-kPa) minimum.
2. Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting, with dimensions matching steel pipe.
3. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.03 CPVC PIPE AND FITTINGS

A. CPVC Pipe: ASTM F 442/F 442M and UL 1821, SDR 13.5, for 175-psig (1200-kPa) rated pressure at 150 deg F (62 deg C), with plain ends. Include "LISTED" and "CPVC SPRINKLER PIPE" markings.

B. CPVC Fittings: UL listed or FM Global approved, for 175-psig (1200-kPa) rated pressure at 150 deg F (62 deg C), socket type. Include "LISTED" and "CPVC SPRINKLER FITTING" markings.

1. NPS 3/4 to NPS 1-1/2 (DN 20 to DN 40): ASTM F 438 and UL 1821, Schedule 40, socket type.
2. NPS 2 to NPS 3 (DN 50 to DN 80): ASTM F 439 and UL 1821, Schedule 80, socket type.
3. CPVC-to-Metal Transition Fittings: CPVC, one piece, with dimensions equivalent to pipe; one end with threaded brass insert, and one socket end.
4. CPVC-to-Metal Transition Unions: CPVC, with dimensions equivalent to pipe; one end with threaded brass insert, and one socket end.
5. Flanges: CPVC, one or two pieces.

C. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493 solvent cement recommended by pipe and fitting manufacturer, and made for joining CPVC sprinkler pipe and fittings. Include cleaner or primer recommended by pipe and fitting manufacturer.

D. Plastic Pipe-Flange Gasket and Bolts and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.04 COVER SYSTEM FOR SPRINKLER PIPING

A. Description: System of support brackets and covers made to protect sprinkler piping.

B. Brackets: Glass-reinforced nylon.

C. Covers: Extruded-PVC sections of length, shape, and size required for size and routing of CPVC piping.

2.05 SPECIALTY VALVES

A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

B. Pressure Rating:

1. Standard-Pressure Piping Specialty Valves: 175-psig (1200-kPa) minimum.

C. Body Material: Cast or ductile iron.

D. Size: Same as connected piping.

E. End Connections: Flanged or grooved.

F. Alarm Valves:

1. Standard: UL 193.
2. Design: For horizontal or vertical installation.
3. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.
4. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
5. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Automatic (Ball Drip) Drain Valves:

1. Standard: UL 1726.
2. Pressure Rating: 175-psig (1200-kPa) minimum.
3. Type: Automatic draining, ball check.
4. Size: NPS 3/4 (DN 20).
5. End Connections: Threaded.

H. Double-Check, Detector-Assembly Backflow Preventers:

1. Standards: ASSE 1048 and UL's "Fire Protection Equipment Directory" listing or FM Global's "Approval Guide."
2. Operation: Continuous-pressure applications.
3. Pressure Loss: 5 psig (35 kPa) maximum, through middle one-third of flow range.
4. Body Material: Cast iron with interior lining complying with AWWA C550 or that is FDA approved, or steel with interior lining complying with AWWA C550 or that is FDA approved.
5. End Connections: Flanged.
6. Configuration: Designed for horizontal, straight through flow.
7. Accessories:

    a. Valves: UL 262 and FM Global's "Approval Guide" listing; OS&Y gate type with flanged ends on inlet and outlet.

2.06 SPRINKLER PIPING SPECIALTIES

A. Branch Outlet Fittings:

1. Standard: UL 213.
2. Pressure Rating: 175-psig (1200-kPa) minimum.
3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
4. Type: Mechanical-tee and -cross fittings.
5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
7. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:

1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
2. Pressure Rating: 175-psig (1200-kPa) minimum.
3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded or grooved.

C. Branch Line Testers:

1. Standard: UL 199.
2. Pressure Rating: 175 psig (1200 kPa).
3. Body Material: Brass.
4. Size: Same as connected piping.
5. Inlet: Threaded.
6. Drain Outlet: Threaded and capped.
7. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:

1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
2. Pressure Rating: 175-psig (1200-kPa) minimum.
3. Body Material: Cast- or ductile-iron housing with sight glass.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.

E. Adjustable Drop Nipples:

1. Standard: UL 1474.
2. Pressure Rating: 250-psig (1725-kPa) minimum.
3. Body Material: Steel pipe with EPDM-rubber O-ring seals.
4. Size: Same as connected piping.
5. Length: Adjustable.
6. Inlet and Outlet: Threaded.

F. Flexible Sprinkler Hose Fittings:

1. Standard: UL 1474.
2. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
3. Pressure Rating: 175-psig (1200-kPa) minimum.
4. Size: Same as connected piping, for sprinkler.

2.07 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Reliable Automatic Sprinkler Co., Inc.
2. Tyco Fire & Building Products LP.
3. Victaulic Company.
4. Viking Corporation.

B. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

C. Pressure Rating for Automatic Sprinklers: 175-psig (1200-kPa) minimum.

D. Automatic Sprinklers with Heat-Responsive Element:

1. Early-Suppression, Fast-Response Applications: UL 1767.
2. Nonresidential Applications: UL 199.
3. Residential Applications: UL 1626.
4. Characteristics: Nominal 1/2-inch (12.7-mm) orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

E. Sprinkler Finishes: Chrome plated.

F. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting: Chrome-plated steel, one piece.
2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

G. Sprinkler Guards:

1. Standard: UL 199.
2. Type: Wire cage with fastening device for attaching to sprinkler.

2.08 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Motor-Operated Alarm:

1. Standard: UL 753.
2. Type: Mechanically operated, with Pelton wheel.
3. Alarm Gong: Cast aluminum with red-enamel factory finish.
4. Size: 8-1/2-inches (216-mm) diameter.
5. Components: Shaft length, bearings, and sleeve to suit wall construction.
6. Inlet: NPS 3/4 (DN 20).
7. Outlet: NPS 1 (DN 25) drain connection.

C. Electrically Operated Alarm Bell:

1. Standard: UL 464.
2. Type: Vibrating, metal alarm bell.

3. Size: 6-inch (150-mm) minimum- diameter.
4. Finish: Red-enamel factory finish, suitable for outdoor use.
5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application

D. Water-Flow Indicators:

1. Standard: UL 346.
2. Water-Flow Detector: Electrically supervised.
3. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
4. Type: Paddle operated.
5. Pressure Rating: 250 psig (1725 kPa).
6. Design Installation: Horizontal or vertical.

E. Pressure Switches:

1. Standard: UL 346.
2. Type: Electrically supervised water-flow switch with retard feature.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design Operation: Rising pressure signals water flow.

F. Valve Supervisory Switches:

1. Standard: UL 346.
2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled valve is in other than fully open position.
5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application

2.09 PRESSURE GAGES

A. Standard: UL 393.

B. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.

C. Pressure Gage Range: 0- to 250-psig (0- to 1725-kPa) minimum.

D. Label: Include "WATER" label on dial face.

PART 3 - EXECUTION

3.01 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.02 SERVICE-ENTRANCE PIPING

A. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements for exterior piping in Section 211100 "Facility Fire-Suppression Water-Service Piping" for exterior piping.

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping.

C. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.03 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.

C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.

E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.

F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

G. Install sprinkler piping with drains for complete system drainage.

H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

I. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

J. Install alarm devices in piping systems.

K. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

L. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 (DN 8) and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.

M. Pressurize and check preaction sprinkler system piping and air-pressure maintenance devices.

N. Fill sprinkler system piping with water.

O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

3.04 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

I. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

J. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.05 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Specialty Valves:

1. Install valves in vertical position for proper direction of flow, in main supply to system.
2. Install alarm valves with bypass check valve and retarding chamber drain-line connection.

3.06 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels.

B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

C. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

3.07 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.08 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Coordinate with fire-alarm tests. Operate as required.
6. Coordinate with fire-pump tests. Operate as required.
7. Verify that equipment hose threads are same as local fire department equipment.

B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.09 CLEANING

A. Clean dirt and debris from sprinklers.

B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.010 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain specialty valves and pressure-maintenance pumps.

3.011 PIPING SCHEDULE

A. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends, cast-iron threaded fittings, and threaded; or grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints.

B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

C. CPVC pipe, Schedule 40 CPVC fittings, and solvent-cemented joints may be used for light-hazard and residential occupancies.

D. Standard-pressure, wet-pipe sprinkler system, NPS 2 (DN 50) and smaller, shall be the following:

1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

E. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 (DN 65) and larger, shall be the following:

1. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.012 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended Ceilings: Pendent, recessed, flush, and concealed sprinklers as indicated.
3. Wall Mounting: Sidewall sprinklers.
4. Spaces Subject to Freezing: Upright sprinklers.

B. Provide sprinkler types in subparagraphs below with finishes indicated.

1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
4. Residential Sprinklers: Dull chrome.
5. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 211313

SECTION 22 00 10 - BASIC MECHANICAL REQUIREMENTS FOR PLUMBING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this and the other sections of Divisions 21, 22, and 23.

1.02 SUMMARY

A. This Section includes general administrative and procedural requirements for mechanical installations.

1.03 CONTRACT DOCUMENTS

A. All work shall be executed in accord with the requirements of national, state, and local codes, regulations, and standards applicable to the trade affected.

B. Should any change in the Contract Documents be required to comply with the governing codes, regulations, and standards, notify the Architect-Engineer prior to the time of submitting a Bid. After entering into the Contract, the Contractor will be held liable to complete all work necessary to meet these requirements without extra cost to the Owner.

C. Should any conflict occur in, or between, the Drawings and Specifications, the Contractor is deemed to have based his Bid on the more expensive material, equipment, product, or work, unless he shall have asked for, and obtained, a written clarification or decision in regard to the conflict from the Architect-Engineer. The written decision, in the form of Addenda to the Contract, shall be obtained prior to submission of the Bid.

D. Work required by the Contract Documents, which exceed the minimum requirements of the governing codes, standards, and regulations shall be done as shown or specified

E. Include payments for fees, permits, inspections, and licensing required for the Mechanical Work under this Division.

F. Payment of assessments and charges levied by the serving utilities, relative to Mechanical Work, shall be paid by the Mechanical Contractor.

G. Arrange for required inspections as early as possible. When possible, have all inspections at the same time.

1.04 DRAWINGS AND MEASUREMENTS

A. Mechanical drawings are diagrammatic and indicate the general arrangement of systems and equipment, except when specifically, dimensioned or detailed. Plumbing, piping, and ductwork plans are intended to show size, capacity, approximate location, direction, and general relationship of one work phase to another, but not the exact detail or arrangement.

B. As the Mechanical drawings are of small scale, it is not possible to show all necessary offsets, fittings, and accessories. Examine General Construction, Mechanical, and Electrical Drawings and Specifications; obtain exact locations, measurements, levels, etc., at the site; arrange systems accordingly; and, at no additional expense to the Owner, furnish fittings, offsets, and accessories as required.

C. Mechanical equipment layout and service clearances are associated with the Basis of Design Equipment Requirements. If Contractor chooses to select equipment from other available manufacturers, the Contractor shall be responsible to verify all chosen manufacturer's service clearance are maintained. If the chosen equipment requires system or building design modifications to obtain these clearances, the Contractor shall be fully responsible for those modifications and associated costs.

1.05 SHOP DRAWING SUBMITTALS

A. Composite Drawings:
1. The Contractor shall prepare composite Drawings and installation layouts when required to solve tight field conditions.
2. Drawings shall consist of dimensioned plans and elevations and shall give complete information, particularly as to size and location of sleeves, inserts, attachments, openings, conduits, ducts, boxes, structural interferences, etc.

B. Product Data:
1. The purpose of submittals by Contractor's is to demonstrate to the Architect-Engineer that the Contractor understands the design concept; and that his understanding is demonstrated by indicating the equipment and materials he intends to furnish and install, and the fabrication and installation methods he intends to use.
2. The Contractor shall become acquainted with the content of the submittals prior to turning the material over to the Architect-Engineer. The Contractor shall review these submittals and make necessary corrections before merely forwarding them to the Architect-Engineer.
3. Do not fabricate or order products or begin work which requires submittals until approval of submittal.
4. Sequentially number submittals. Revised submittals should include original number and a sequential alphabetic suffix.
5. Submit manufacturer's printed literature in original form. Any fading type of reproduction for example - a “second generation” facsimile will not be accepted.
6. Each submittal shall be complete and in sufficient detail to allow ready determination of compliance with the contract requirements.
   a. Provide manufacturers catalog sheets, brochures, standard diagrams, schematics, schedules, performance charts, illustrations and other standard descriptive data. Where printed literature describes items in addition to that item being submitted, the submitted item shall be clearly marked on the sheet and superfluous information shall be crossed out. Delete information which is not applicable to the Contract.
   b. The Contractor shall supplement standard information with additional information applicable to this Contract, and indicate dimensions, clearances, performance characteristics, capacities, wiring and piping diagrams, and controls. Clearly delineate the following information:
      1) Applicable Contract Specification Section Numbers.
      2) Applicable Standards, such as ASTM or Federal specification numbers.
      3) Clearly mark each copy to identify pertinent product, or models. Show descriptive names of materials and equipment, classified item numbers, and locations at which materials or equipment are to be installed in the Work. Use the same reference identification as shown on Contract Drawings.
      4) Show physical dimensions, weights, and clearances required.
      5) Furnish performance curves for all pumps and fans
      6) Show performance data consisting of equipment capabilities, RPM, KW, pressure drops, design and operating points, pressures, temperatures, noise level curves, power characteristics and consumption; conforming as closely as possible to the test methods referenced in the plans and specifications.
      7) Show wiring or piping diagrams and controls.
      8) Identify any and all deviations from the Contract Drawings and specifications.
7. The Contractor’s stamp, initialed or signed, shall certify dimensional compatibility of the product(s) with the space in which it is intended to be used. Furthermore, it shall signify his review of the submittal(s) for compliance with Contract requirements.

C. Reviewed Submittals: The Architect-Engineer's review of submittals shall not be construed as a complete check, but will indicate only that the general method of construction, materials, detailing and other information are satisfactory. Review will not relieve the Contractor of the responsibility for any error which may exist, as the Contractor is responsible for dimensions, the design of adequate connections and details, and the satisfactory construction of all work. After submittals have been reviewed by the Architect-Engineer, no resubmittal for the purpose of substituting materials or equipment will be considered unless accompanied by an explanation of why a substitution is necessary, and the Architect-Engineer is financially compensated for the additional review.

D. Deviations: For submittals which include proposed deviations requested by the Contractor, the proposed deviations from the contract requirements shall be clearly identified. The Contractor shall set forth in writing the reason for any deviations and annotate such deviations on the submittal.

1.06 QUALITY OF WORK

A. All work shall be of the best quality free from defects in workmanship, materials, and performance.

1.07 DELIVERY AND RECEIVING

A. Arrange deliveries of products in accordance with construction progress schedules. Allow time for inspection prior to installation.

B. Coordinate deliveries to avoid conflict with work and conditions at site, work of other contractors, limitations on storage space, availability of personnel and handling equipment.

C. Deliver products in undamaged, dry condition, in original unopened containers or packaging with identifying labels intact and legible.

D. Clearly mark partial deliveries of component parts of equipment to identify equipment and contents to permit easy accumulation of parts and to facilitate assembly.

1.08 STORAGE, GENERAL

A. Store products, immediately on delivery, in accordance with manufacturer's instructions, with seals and labels intact. Protect until installed.

B. Arrange storage in a manner to provide access for maintenance of stored items and for inspection.

C. Protect products from dirt, including construction dust. Products left exposed to dirt or dust must be thoroughly cleaned to the satisfaction of the Engineer prior to installation.

1.09 ENCLOSED STORAGE

A. Store products, subject to damage by the elements, in substantial weather tight enclosures.

B. Maintain temperature and humidity within ranges stated in manufacturer’s instructions.

C. Provide humidity control and ventilation for sensitive products as required by manufacturer’s instructions.

D. Store unpacked and loose products on shelves, in bins, or in neat groups of like items.

1.010 EXTERIOR STORAGE

A. Provide substantial platforms, blocking, or skids, to support fabricated products above ground; slope to provide drainage. Protect products from soiling and staining.

B. For products subject to discoloration or deterioration from exposure to the elements, cover with impervious sheet material. Provide ventilation to avoid condensation.

C. Store loose granular materials on clean, solid surfaces such as pavement, or on rigid sheet material, to prevent mixing with foreign matter.

D. Provide surface drainage to prevent erosion and ponding of water.

1.011 SUBSTITUTIONS

A. Refer to front portion of the specifications.

B. The Owner shall be the sole and final judge as to the suitability of items substituted for those specified. **Requests for substitutions shall be submitted no later than ten (10) days prior to the day of bid opening**. If prior approval is not granted, equipment shall be furnished as specified or as shown on the plans.

C. The entire cost of all changes of any type due to substitutions for materials specified shall be borne by the Contractor at no extra cost to the Owner & shall reimburse other trades of additional cost due to substitution.

D. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals without separate written request, or when acceptance will require substantial revision of Contract Documents

1.012 CHANGE ORDERS

A. Refer to front portion of the specifications.

B. The Contractor shall, in no instance, commence work on, or provide materials for or make changes in, the work for this project which will require additional payment from the Owner to the Contractor until he has requested and obtained, in writing, either a signed written Change Order or a signed written notice to proceed with the extra work.

C. Each request for approval of additional work which is to require additional payment from the Owner, or in instances where credit is to be allowed to the Owner for omission of certain work or materials, shall be accompanied by a price quotation, including a complete cost breakdown of materials, labor, overhead and profit.

1.013 OPERATING AND MAINTENANCE MANUAL

A. Refer to front portion of the specifications and to each Section of Divisions 22 and 23.

B. The Contractor shall furnish three (3) Operating and Maintenance Manuals to the Owner after all tests and adjustments have been completed. Final payment will not be made until this manual has been submitted and approved. In addition to the requirements of the front portion of these specifications, the manual shall include but not limited to:

1. Binder: All of the above described items shall be assembled in a three-ring binder with a hard cover and durable cloth or plastic finish.
2. Index: A complete index shall be included at the front of the manual.
3. Name, Address and Telephone of the Manufacturer and Local Representative: Include a list of all suppliers and representatives of products supplied on the project shall be included in the manual.
4. Valve List: A list of all valves with the number and function of each valve shall be included in the manual.
5. V-Belt and Filter List: A list of all V-belts and filters with sizes, types and quantities required by each piece of equipment shall be included in the manual.
6. Shop Drawings: One copy of each approved shop drawing shall be included in the manual.
7. Manufacturers' Manuals and Parts Lists: Operating and maintenance manuals and parts lists furnished by equipment manufacturers shall be included in the manual.
8. Startup and Shutdown Procedures: A written description of the procedure for starting up and shutting down each mechanical system shall be included in the manual. This description shall include motors to start, valves to open, etc., in proper sequence and location of switches, starters, push buttons and valves.
9. Seasonal Changeover Procedure (if applicable): A written description of the procedures necessary for seasonal changeover from heating to cooling and vice versa shall be included in the manual.
10. Manufacturers Start-up of Equipment Documentation: Documents shall include date and time of start-up, name of authorized personnel who performed star-up, any required settings and notes concerning start-up shall be included in the manual.
11. State or City Tests, Approval, or Acceptance of Equipment and/or systems: This shall include date, time, name of authorized personnel and any other notes. Documentation of domestic water sterilization and equipment approved installation start-ups shall be included in the manual.
12. Reports: Include air and water balancing reports.

1.014 AS-BUILT DRAWINGS

A. Refer to front portion of the specifications.

B. This Contractor shall prepare as-built drawings for the various component portions of the mechanical installations. These drawings shall be furnished to the Owner after completion of the work. These drawings shall be prepared by marking up a set of contract drawings with colored pencils to show changes made during construction after the various installations have been completed.

1.015 GUARANTEE

A. Refer to front portion of the specifications.

B. The Contractor shall guarantee that all mechanical systems shall be free from defects in workmanship, materials and performance to specified capacities and that if such defects shall appear during a period of one year, or as specified in another section, from date of final acceptance, he will remedy such defects to the satisfaction of the Owner at no extra cost.

1.016 EXTRA MATERIALS

A. Furnish extra materials as described in each Division 22 and 23 sections and items are packaged with protective covering for storage and identified with labels describing contents.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.01 MECHANICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:
1. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
2. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
3. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
4. Coordinate noisy or loud work to be completed during non-business working hours, weekends or during designated times from Owner.

END OF SECTION 220010

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SECTION 22 05 13 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.03 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

2.02 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with

indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.03 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Rotor: Random-wound, squirrel cage.

E. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

F. Temperature Rise: Match insulation rating.

G. Insulation: Class F.

H. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

I. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

J. Provide with auxiliary contacts as required for control interlocks.

2.04 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
3. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.05 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

F. Provide with auxiliary contacts as required for control interlocks.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 220513

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SECTION 22 05 16 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Rubber union connector packless expansion joints.
2. Flexible-hose packless expansion joints.
3. Metal-bellows packless expansion joints.
4. Externally pressurized metal-bellows packless expansion joints.
5. Rubber packless expansion joints.
6. Grooved-joint expansion joints.
7. Alignment guides and anchors.
8. Pipe loops and swing connections.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Delegated-Design Submittal: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
3. Alignment Guide Details: Detail field assembly and attachment to building structure.
4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

1.04 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.05 CLOSEOUT SUBMITTALS

A. Maintenance Data: For expansion joints to include in maintenance manuals.

1.06 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

2.02 PACKLESS EXPANSION JOINTS

A. Rubber Union Connector Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Flexicraft Industries.
    b. Mason Industries, Inc.

2. Material: Twin reinforced-rubber spheres.
3. Minimum Pressure Rating: 150 psig at 170 deg F (1035 kPa at 77 deg C), unless otherwise indicated.
4. End Connections for NPS 2 (DN 50) and Smaller: Threaded.

B. Flexible-Hose Packless Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Flexicraft Industries.
    b. Mason Industries, Inc.
    c. Metraflex Company (The).

2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
4. Expansion Joints for Copper Tubing NPS 2 (DN 50) and Smaller: Copper-alloy fittings with solder-joint end connections.

    a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F (3100 kPa at 21 deg C) and 340 psig at 450 deg F (2340 kPa at 232 deg C) ratings.
    b. Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F (4830 kPa at 21 deg C) and 500 psig at 450 deg F (3450 kPa at 232 deg C) ratings.

5. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Copper-alloy fittings with threaded end connections.

    a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F (2070 kPa at 21 deg C) and 225 psig at 450 deg F (1550 kPa at 232 deg C) ratings.
    b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 420 psig at 70 deg F (2890 kPa at 21 deg C) and 315 psig at 450 deg F (2170 kPa at 232 deg C) ratings.

6. Expansion Joints for Steel Piping NPS 2 (DN 50) and Smaller: Carbon-steel fittings with threaded end connections.

    a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F (3100 kPa at 21 deg C) and 325 psig at 600 deg F (2250 kPa at 315 deg C) ratings.
    b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 700 psig at 70 deg F (4830 kPa at 21 deg C) and 515 psig at 600 deg F (3550 kPa at 315 deg C) ratings.

7. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Carbon-steel fittings with flanged end connections.

    a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F (1380 kPa at 21 deg C) and 145 psig at 600 deg F (1000 kPa at 315 deg C) ratings.
    b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 275 psig at 70 deg F (1900 kPa at 21 deg C) and 200 psig at 600 deg F (1380 kPa at 315 deg C) ratings.

8. Expansion Joints for Steel Piping NPS 8 to NPS 12 (DN 200 to DN 300): Carbon-steel fittings with flanged end connections.

    a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70 deg F (860 kPa at 21 deg C) and 90 psig at 600 deg F (625 kPa at 315 deg C) ratings.

b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F (1130 kPa at 21 deg C) and 120 psig at 600 deg F (830 kPa at 315 deg C) ratings.

9. Expansion Joints for Steel Piping NPS 14 (DN 350) and Larger: Carbon-steel fittings with flanged end connections.

a. Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F (1130 kPa at 21 deg C) and 120 psig at 600 deg F (830 kPa at 315 deg C) ratings.

C. Metal-Bellows Packless Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Flexicraft Industries.
b. Mason Industries, Inc.
c. Metraflex Company (The).

2. Standards: ASTM F 1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
3. Type: Circular, corrugated bellows.
4. Minimum Pressure Rating: 150 psig (1035 kPa), unless otherwise indicated.
5. Configuration: Single joint class(es), unless otherwise indicated.
6. Expansion Joints for Copper Tubing: Single- or multi- ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.

a. End Connections for Copper Tubing NPS 2 (DN 50) and Smaller: Solder joint or threaded.
b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Solder joint or threaded.
c. End Connections for Copper Tubing NPS 5 (DN 125) and Larger: Flanged.

7. Expansion Joints for Steel Piping: Single- or multi- ply stainless-steel bellows, steel pipe ends, and carbon-steel shroud.

a. End Connections for Steel Pipe NPS 2 (DN 50) and Smaller: Threaded.
b. End Connections for Steel Pipe NPS 2-1/2 (DN 65) and Larger: Flanged.

D. Externally Pressurized Metal-Bellows Packless Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Flexicraft Industries.
b. Mason Industries, Inc.
c. Metraflex Company (The).

2. Minimum Pressure Rating: 150 psig (1035 kPa), unless otherwise indicated.
3. Description:

a. Totally enclosed, externally pressurized, multi-ply, stainless-steel bellows isolated from fluid flow by an internal pipe sleeve.
b. Carbon-steel housing.
c. Drain plugs and lifting lug for NPS 3 (DN 80) and larger.
d. Joint Axial Movement: 4 inches (100 mm) of compression and 0.75 inch (19 mm) of extension.

4. Permanent Locking Bolts: Set locking bolts to maintain joint lengths during installation. Temporary welding tabs that are removed after installation in lieu of locking bolts are not acceptable.
5. End Connection Configuration: Flanged; one raised, fixed and one floating flange.

E. Rubber Packless Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Flexicraft Industries.
b. Mason Industries, Inc; Mercer Rubber Co.
c. Metraflex Company (The).

2. Standards: ASTM F 1123 and FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."
3. Material: Fabric-reinforced rubber complying with FSA-PSJ-703.
4. Arch Type: Single or multiple arches.
5. Spherical Type: Single or multiple spheres.
6. Minimum Pressure Rating for NPS 1-1/2 to NPS 4 (DN 40 to DN 100): 150 psig (1035 kPa) at 220 deg F (104 deg C).
7. Minimum Pressure Rating for NPS 5 and NPS 6 (DN 125 and DN 150): 140 psig (966 kPa) at 200 deg F (93 deg C).
8. Minimum Pressure Rating for NPS 8 to NPS 12 (DN 200 to DN 300): 140 psig (966 kPa) at 180 deg F (82 deg C).
9. Material for Fluids Containing Acids, Alkalis, or Chemicals: Butyl rubber.
10. Material for Fluids Containing Gas, Hydrocarbons, or Oil: Buna-N.
11. Material for Water: Butyl rubber or Buna-N.
12. End Connections: Full-faced, integral steel flanges with steel retaining rings.

2.03 GROOVED-JOINT EXPANSION JOINTS

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Anvil International, Inc.
b. Shurjoint Piping Products.
c. Victaulic Company.

B. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.

C. Standard: AWWA C606, for grooved joints.

D. Nipples: Galvanized, ASTM A 53/A 53M, Schedule 40, Type E or S, steel pipe with grooved ends.

E. Couplings: Five, flexible type for steel-pipe dimensions. Include ferrous housing sections, Buna-N gasket suitable for diluted acid, alkaline fluids, and cold and hot water, and bolts and nuts.

2.04 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Flexicraft Industries.
    b. Mason Industries, Inc.
    c. Metraflex Company (The).

2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe.

B. Anchor Materials:

1. Steel Shapes and Plates: ASTM A 36/A 36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
3. Washers: ASTM F 844, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.

    a. Stud: Threaded, zinc-coated carbon steel.
    b. Expansion Plug: Zinc-coated steel.
    c. Washer and Nut: Zinc-coated steel.

5. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.

    a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
    b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
    c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.01 EXPANSION JOINT INSTALLATION

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

B. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

C. Install rubber packless expansion joints according to FSA-PSJ-703.

D. Install grooved-joint expansion joints to grooved-end steel piping.

3.02 PIPE LOOP AND SWING CONNECTION INSTALLATION

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.

C. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.

D. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.03 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install one guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

C. Attach guides to pipe, and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:

1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24; U bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.

G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 22016

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Grout.
4. Silicone sealants.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.

B. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized, with plain ends and integral welded waterstop collar.

C. Galvanized-Steel Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

A. Description:

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20 psig (137 kPa) minimum.
3. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
4. Pressure Plates: Carbon steel or stainless steel.
5. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B 633 or stainless steel of length required to secure pressure plates to sealing elements.

2.3 GROUT

A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.4 SILICONE SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C 920, Type S, Grade NS, Class 25, Use NT.

B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.

C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.

2. Using grout or silicone sealant, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade: Cast-iron pipe sleeves with sleeve-seal system, galvanized-steel sheet sleeves with sleeve-seal system, or galvanized-steel-pipe sleeves with sleeve-seal system.

    a. Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

2. Exterior Concrete Walls below Grade: Cast-iron pipe sleeves with sleeve-seal system, galvanized-steel sheet sleeves with sleeve-seal system, or galvanized-steel-pipe sleeves with sleeve-seal system.

    a. Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade: Cast-iron pipe sleeves with sleeve-seal system, galvanized-steel sheet sleeves with sleeve-seal system, or galvanized-steel-pipe sleeves with sleeve-seal system.

    a. Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade: Galvanized-steel-pipe sleeves.

5. Interior Partitions:

    a. Piping Smaller than NPS 6 (DN 150): Galvanized-steel-pipe sleeves.
    b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 220517

SECTION 22 05 18 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 ESCUTCHEONS

A. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.

B. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

C. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished, chrome-plated finish and spring-clip fasteners.

D. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.

E. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.

2.02 FLOOR PLATES

A. Split Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
g. Bare Piping in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated finish.

h. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
i. Chrome-Plated Piping: One-piece cast brass with polished, chrome-plated finish.
j. Insulated Piping: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
k. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated finish.
l. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated finish.
m. Bare Piping in Unfinished Service Spaces: One-piece cast brass with polished, chrome-plated finish.
n. Bare Piping in Equipment Rooms: One-piece cast brass with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor plate.

3.02 FIELD QUALITY CONTROL

A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION 220518

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SECTION 22 05 19 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Liquid-in-glass thermometers.
2. Thermowells.
3. Dial-type pressure gages.
4. Gage attachments.
5. Test plugs.

B. Related Requirements:

1. Section 221113 "Facility Water Distribution Piping" for domestic water meters and combined domestic and fire-protection water-service meters outside the building.
2. Section 221119 "Domestic Water Piping Specialties" for water meters.
3. Section 221513 "General-Service Compressed-Air Piping" for compressed air gages.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.04 INFORMATIONAL SUBMITTALS

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Miljoco Corporation.
    b. Trerice, H. O. Co.
    c. Weiss Instruments, Inc.
    d. Weksler Glass Thermometer Corp.
    e. Winters Instruments - U.S.

2. Standard: ASME B40.200.
3. Case: Cast aluminum; 9-inch (229-mm) nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass or plastic.
8. Stem: Aluminum and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

9. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.02 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, (DN 15, DN 20, or NPS 25,) ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.03 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Miljoco Corporation.
    b. Trerice, H. O. Co.
    c. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
    d. Weiss Instruments, Inc.
    e. Weksler Glass Thermometer Corp.
    f. Winters Instruments - U.S.

2. Standard: ASME B40.100.
3. Case: Sealed type; cast aluminum or drawn stainless steel; 4-1/2-inch (114-mm) nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass or plastic.
10. Ring: Stainless steel.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.04 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass or stainless-steel needle, with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads.

2.05 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    1. Miljoco Corporation.
    2. Trerice, H. O. Co.
    3. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
    4. Weiss Instruments, Inc.
    5. Weksler Glass Thermometer Corp.

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 (DN 8) or NPS 1/2 (DN 15), ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 kPa at 93 deg C).

F. Core Inserts: EPDM self-sealing rubber.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

G. Install valve and snubber in piping for each pressure gage for fluids.

H. Install test plugs in piping tees.

I. Install thermometers in the following locations:

1. Inlet and Outlet of each water heater.
2. Inlets and outlets of each domestic water heat exchanger.
3. Inlet and outlet of each domestic hot-water storage tank.
4. Elsewhere as shown on the plans.

J. Install pressure gages in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each domestic water booster pump.
4. Elsewhere as shown on the plans.

3.02 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.03 ADJUSTING

A. Adjust faces of meters and gages to proper angle for best visibility.

3.04 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each domestic water heater shall be the following:

1. Sealed, bimetallic-actuated type.
2. Industrial-style, liquid-in-glass type.
3. Direct-mounted, light-activated type.
4. Test plug with EPDM self-sealing rubber inserts.

B. Thermometers at inlets and outlets of each domestic water heat exchanger shall be the following:

1. Sealed, bimetallic-actuated type.
2. Industrial-style, liquid-in-glass type.
3. Direct-mounted, light-activated type.
4. Test plug with EPDM self-sealing rubber inserts.

C. Thermometers at inlet and outlet of each domestic hot-water storage tank shall be the following:

1. Sealed, bimetallic-actuated type.
2. Industrial-style, liquid-in-glass type.
3. Direct-mounted, light-activated type.
4. Test plug with EPDM self-sealing rubber inserts.

D. Thermometer stems shall be of length to match thermowell insertion length.

3.05 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F (Minus 20 to plus 50 deg C).

B. Scale Range for Domestic Hot-Water Piping: 30 to 240 deg F (0 to plus 115 deg C).

C. Scale Range for Domestic Cooled-Water Piping: 0 to 100 deg F (Minus 20 to plus 50 deg C).

3.06 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each water service into building shall be the following:

1. Dry, direct-mounted, metal case.
2. Test plug with EPDM self-sealing rubber inserts.

B. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be the following:

1. Dry, direct-mounted, metal case.
2. Test plug with EPDM self-sealing rubber inserts.

C. Pressure gages at suction and discharge of each domestic water booster pump shall be the following:

1. Dry, direct-mounted, metal case.
2. Test plug with EPDM self-sealing rubber inserts.

3.07 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 100 psi (0 to 600 kPa).

B. Scale Range for Domestic Water Piping: 0 to 100 psi (0 to 600 kPa).

END OF SECTION 220519

SECTION 22 05 23.12 - BALL VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.
3. Steel ball valves.
4. Iron ball valves.

1.03 DEFINITIONS

A. CWP: Cold working pressure.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1. Certification that products comply with NSF 61 Annex G.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and soldered ends.
3. Set ball valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on steel valves.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for solder-joint connections.
6. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 Annex G for valve materials for potable-water service.

D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 4 (DN 100) and larger.
2. Handlever: For quarter-turn valves smaller than NPS 4 (DN 100).

H. Valves in Insulated Piping:

1. Include 2-inch (50-mm) stem extensions.
2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

2.02 BRASS BALL VALVES

A. Brass Ball Valves, Two-Piece with Full Port and Brass Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-110.
b. CWP Rating: 600 psig (4140 kPa).
c. Body Design: Two piece.
d. Body Material: Forged brass.
e. Ends: Threaded and soldered.
f. Seats: PTFE.
g. Stem: Brass.
h. Ball: Chrome-plated brass.
i. Port: Full.

B. Brass Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-110.
b. CWP Rating: 600 psig (4140 kPa).
c. Body Design: Two piece.
d. Body Material: Forged brass.
e. Ends: Threaded and soldered.
f. Seats: PTFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel, vented.
i. Port: Full.

2.03 BRONZE BALL VALVES

A. Bronze Ball Valves, Two-Piece with Full Port, and Bronze or Brass Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-110.
b. CWP Rating: 600 psig (4140 kPa).
c. Body Design: Two piece.
d. Body Material: Bronze.
e. Ends: Threaded and soldered.
f. Seats: PTFE.
g. Stem: Bronze or brass.
h. Ball: Chrome-plated brass.
i. Port: Full.

B. Bronze Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-110.
b. CWP Rating: 600 psig (4140 kPa).
c. Body Design: Two piece.
d. Body Material: Bronze.
e. Ends: Threaded or soldered.
f. Seats: PTFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel, vented.
i. Port: Full.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.03 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

B. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.

6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.

3.04 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 PSIG OR LESS)

A. Pipe NPS 2 (DN 50) and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Two-piece, brass ball valves with full port and brass trim.
3. Two-piece, bronze ball valves with full port and bronze or brass trim.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Steel and Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
2. Class 150, steel ball valves with full port.
3. Class 150, iron ball valves.

3.05 HIGH-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 TO 200 PSIG)

A. Pipe NPS 2 (DN 50) and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Two-piece, brass ball valves with full port and brass trim.
3. Two-piece, bronze ball valves with full port and bronze or brass trim.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Steel and Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
2. Class 150, steel ball valves with full port.
3. Class 150, iron ball valves.

3.06 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Two-piece, brass ball valves with full port and brass trim.
3. Two-piece, bronze ball valves with full port and bronze or brass trim.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Steel and Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
2. Class 150, steel ball valves with full port.

3. Class 125, iron ball valves.

END OF SECTION 220523.12

SECTION 22 05 23.13 - BUTTERFLY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Iron, single-flange butterfly valves.
2. Iron, grooved-end butterfly valves.

1.03 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene-diene terpolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1. Certification that products comply with NSF 61 Annex G.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set butterfly valves closed or slightly open.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.1 for flanges on iron valves.
2. ASME B16.5 for flanges on steel valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B31.9 for building service piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. NSF Compliance: NSF 61 Annex G for valve materials for potable-water service.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Actuator Types:

1. Gear Actuator: For valves NPS 8 (DN 200) and larger.
2. Handlever: For valves NPS 6 (DN 150) and smaller.

H. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions.

2.02 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. Iron, Single-Flange Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM or NBR (see schedule in Part 3).
f. Stem: One- or two-piece stainless steel.
g. Disc: Aluminum bronze or Stainless steel.

2.03 DUCTILE-IRON, GROOVED-END BUTTERFLY VALVES

A. Iron, Grooved-End Butterfly Valves, 175 CWP:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Kennedy Valve; a division of McWane, Inc.
b. Shurjoint Piping Products.
c. Tyco Fire Products LP; Grinnell Mechanical Products.
d. Victaulic Company.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 175 psig (1200 kPa).
c. Body Material: Coated, ductile iron.
d. Stem: Two-piece stainless steel.
e. Disc: Coated, ductile iron.
f. Seal: EPDM.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine mating flange faces for damage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

D. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.03 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 PSIG OR LESS)

A. Iron, Single-Flange Butterfly Valves: 200 CWP, NBR seat, aluminum-bronze or stainless-steel disc.

B. Ductile-Iron, Grooved-End Butterfly Valves: 175 CWP.

3.05 HIGH-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 TO 200 PSIG)

A. Iron, Single-Flange Butterfly Valves: 200 CWP, NBR seat, aluminum-bronze or stainless-steel disc.

3.06 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, aluminum-bronze or stainless-steel disc.

B. Ductile-Iron, Grooved-End Butterfly Valves: 175 CWP.

END OF SECTION 220523.13

SECTION 22 05 23.14 - CHECK VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Bronze swing check valves.
2. Iron swing check valves.
3. Iron swing check valves with closure control.

1.03 DEFINITIONS

A. CWP: Cold working pressure.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1. Certification that products comply with NSF 61 Annex G.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B16.18 for solder joint.
5. ASME B31.9 for building services piping valves.

C. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.02 BRONZE SWING CHECK VALVES

A. Bronze Swing Check Valves with Nonmetallic Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Hammond Valve.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded or soldered. See valve schedule articles.
f. Disc: PTFE.

B. Bronze Swing Check Valves with Nonmetallic Disc, Class 150:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Hammond Valve.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 300 psig (2070 kPa).
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded or soldered. See valve schedule articles.
f. Disc: PTFE.

2.03 IRON SWING CHECK VALVES

A. Iron Swing Check Valves with Nonmetallic-to-Metal Seats, Class 125:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Hammond Valve.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged or threaded. See valve schedule articles.
f. Trim: Composition.
g. Seat Ring: Bronze.
h. Disc Holder: Bronze.
i. Disc: PTFE.
j. Gasket: Asbestos free.

B. Iron Swing Check Valves with Metal Seats, Class 250:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Hammond Valve.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-71, Type I.
b. CWP Rating: 500 psig (3450 kPa).
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged or threaded. See valve schedule articles.
f. Trim: Bronze.
g. Gasket: Asbestos free.

2.04 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Iron Swing Check Valves with Lever- and Spring-Closure Control, Class 125:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Hammond Valve.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged or threaded. See valve schedule articles.
f. Trim: Bronze.
g. Gasket: Asbestos free.
h. Closure Control: Factory-installed exterior lever and weight.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Check Valves: Install check valves for proper direction of flow.

1. Swing Check Valves: In horizontal position with hinge pin level.

F. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.03 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Pump-Discharge Check Valves:

a. NPS 2 (DN 50) and Smaller: Bronze swing check valves with nonmetallic disc.
b. NPS 2-1/2 (DN 65) and Larger for Domestic Water: Iron swing check valves with lever and weight or spring.
c. NPS 2-1/2 (DN 65) and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

C. End Connections:

1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded or soldered.
2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged or threaded.
3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged.
4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded.
5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged or threaded.
6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged.

3.05 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 PSIG OR LESS)

A. Pipe NPS 2 (DN 50) and Smaller: Bronze swing check valves, Class 125, nonmetallic disc with soldered or threaded end connections.

B. Pipe NPS 2-1/2 (DN 65) and Larger: Iron swing check valves, Class 125, nonmetallic-to-metal seats with threaded or flanged end connections.

3.06 HIGH-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 TO 200 PSIG)

A. Pipe NPS 2 (DN 50) and Smaller: Horizontal and Vertical Applications: Bronze swing check valves, Class 150, nonmetallic disc with soldered or threaded end connections.

B. Pipe NPS 2-1/2 (DN 65) and Larger: Iron swing check valves, Class 250, metal seats with threaded or flanged end connections.

3.07 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller: Bronze swing check valves, Class 125, nonmetallic disc with soldered or threaded end connections.

B. Pipe NPS 2-1/2 (DN 65) and Larger: Iron swing check valves, Class 125, nonmetallic-to-metal seats with threaded or flanged end connections.

END OF SECTION 220523.14

SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Pipe positioning systems.
8. Equipment supports.

B. Related Requirements:
1. Section 220516 "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.

1.03 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Pipe stands.
4. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Include design calculations for designing trapeze hangers.

1.05 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.06 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

B. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

2.02 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pre-galvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated or epoxy powder coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe and Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

2.03 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.04 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.
   c. Flex-Strut Inc.
   d. GS Metals Corp.
   e. Thomas & Betts Corporation.
   f. Unistrut Corporation; Tyco International, Ltd.
   g. Wesanco, Inc.

2. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.
7. Metallic Coating: Electroplated zinc.

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Anvil International; a subsidiary of Mueller Water Products Inc.
    b. Empire Industries, Inc.
    c. ERICO International Corporation.
    d. Haydon Corporation; H-Strut Division.
    e. NIBCO INC.
    f. PHD Manufacturing, Inc.
    g. PHS Industries, Inc.

2. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.
7. Metallic Coating: Pre-galvanized G90 (Z275).

2.05 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carpenter & Paterson, Inc.
2. Clement Support Services.
3. ERICO International Corporation.
4. National Pipe Hanger Corporation.
5. PHS Industries, Inc.
6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.06 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless- steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.07 PIPE STANDS

A. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Stainless steel.
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

B. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: One or more; plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

C. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

D. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

E. Compact Pipe Stand:

1. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
3. Hardware: Galvanized steel or polycarbonate.
4. Accessories: Protection pads.

F. Low-Profile, Single-Base, Single-Pipe Stand:

1. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
3. Vertical Members: Two galvanized or stainless-steel, continuous-thread, 1/2-inch (12-mm) rods.
4. Horizontal Member: Adjustable horizontal, galvanized or stainless-steel pipe support channels.
5. Pipe Supports: Strut clamps.
6. Hardware: Galvanized or Stainless steel.
7. Accessories: Protection pads.
8. Height: 12 inches (300 mm) above roof.

G. High-Profile, Single-Base, Single-Pipe Stand:

1. Description: Single base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Single vulcanized rubber or molded polypropylene.
3. Vertical Members: Two galvanized or stainless-steel, continuous-thread, 1/2-inch (12-mm) rods.
4. Horizontal Member: One adjustable-height, galvanized- or stainless-steel, pipe-support slotted channel or plate.
5. Pipe Supports: Roller.
6. Hardware: Galvanized or Stainless steel.
7. Accessories: Protection pads.
8. Height: 36 inches (900 mm) above roof.

H. High-Profile, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: Two or more; vulcanized rubber or molded polypropylene.
3. Vertical Members: Two or more, galvanized or stainless-steel channels.
4. Horizontal Members: One or more, adjustable-height, galvanized-steel pipe support.
5. Pipe Supports: Strut clamps.
6. Hardware: Galvanized or Stainless steel.
7. Accessories: Protection pads.
8. Height: 36 inches (900 mm) above roof.

I. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.08 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, positioning system composed of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.09 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.010 MISCELLANEOUS MATERIALS

A. Aluminum: ASTM B 221 (ASTM B 221M).

B. Carbon Steel: ASTM A 1011/A 1011M.

C. Structural Steel: ASTM A 36/A 36M carbon-steel plates, shapes, and bars; black and galvanized.

D. Stainless Steel: ASTM A 240/A 240M.

E. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.01 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

3.02 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

G. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

K. Install lateral bracing with pipe hangers and supports to prevent swaying.

L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete

inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

M. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

O. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating Below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
    b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
    c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
    d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
    e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.

5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.03 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.04 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.05 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.06 PAINTING

A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in Section 099123 "Interior Painting."

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.07 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.

6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8 (DN 20 to DN 200).
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction occurs.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction occurs.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction occurs but vertical adjustment is unnecessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 (DN 50 to DN 600) if small horizontal movement caused by expansion and contraction occurs and vertical adjustment is unnecessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 (DN 50 to DN 750) if vertical and lateral adjustment during installation, in addition to expansion and contraction, is required.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment of up to 6 inches (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb (340 kg).
    b. Medium (MSS Type 32): 1500 lb (680 kg).
    c. Heavy (MSS Type 33): 3000 lb (1360 kg).

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

P. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

S. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

SECTION 22 05 48.13 - VIBRATION CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring isolators.
6. Restrained-spring isolators.
7. Housed-restrained-spring isolators.
8. Pipe-riser resilient supports.
9. Resilient pipe guides.
10. Elastomeric hangers.
11. Spring hangers.

B. Related Requirements:

1. Section 230548.13 "Vibration Controls for HVAC" for devices for HVAC equipment and systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ace Mountings Co., Inc.
b. California Dynamics Corporation.
c. Isolation Technology, Inc.
d. Kinetics Noise Control, Inc.
e. Mason Industries, Inc.
f. Vibration Eliminator Co., Inc.
g. Vibration Isolation.
h. Vibration Mountings & Controls, Inc.

2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Pad Material: Oil and water resistant with elastomeric properties.

2.2 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ace Mountings Co., Inc.
b. California Dynamics Corporation.
c. Isolation Technology, Inc.
d. Kinetics Noise Control, Inc.

e. Mason Industries, Inc.
f. Vibration Eliminator Co., Inc.
g. Vibration Isolation.
h. Vibration Mountings & Controls, Inc.

2. Mounting Plates:

a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded.

3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.3 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ace Mountings Co., Inc.
b. California Dynamics Corporation.
c. Isolation Technology, Inc.
d. Kinetics Noise Control, Inc.
e. Mason Industries, Inc.
f. Vibration Eliminator Co., Inc.
g. Vibration Isolation.
h. Vibration Mountings & Controls, Inc.

2. Description: All-directional isolator with restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

a. Housing: Cast-ductile iron or welded steel.
b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 OPEN-SPRING ISOLATORS

2.5 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ace Mountings Co., Inc.
b. California Dynamics Corporation.

c. Isolation Technology, Inc.
d. Kinetics Noise Control, Inc.
e. Mason Industries, Inc.
f. Vibration Eliminator Co., Inc.
g. Vibration Isolation.
h. Vibration Mountings & Controls, Inc

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig (3447 kPa).
7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.6 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ace Mountings Co., Inc.
b. California Dynamics Corporation.
c. Isolation Technology, Inc.
d. Kinetics Noise Control, Inc.
e. Mason Industries, Inc.
f. Vibration Eliminator Co., Inc.
g. Vibration Isolation.
h. Vibration Mountings & Controls, Inc.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.

a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
b. Top housing with attachment and leveling bolt.

2.7 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Ace Mountings Co., Inc.
    b. California Dynamics Corporation.
    c. Isolation Technology, Inc.
    d. Kinetics Noise Control, Inc.
    e. Mason Industries, Inc.
    f. Vibration Eliminator Co., Inc.
    g. Vibration Isolation.
    h. Vibration Mountings & Controls, Inc.

2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

    a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
    b. Top plate with threaded mounting holes.
    c. Internal leveling bolt that acts as blocking during installation.

3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.8 HOUSED-RESTRAINED-SPRING ISOLATORS

A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Ace Mountings Co., Inc.
    b. California Dynamics Corporation.
    c. Isolation Technology, Inc.
    d. Kinetics Noise Control, Inc.
    e. Mason Industries, Inc.
    f. Vibration Eliminator Co., Inc.
    g. Vibration Isolation.
    h. Vibration Mountings & Controls, Inc.

2. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.

    a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
    b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.9 PIPE-RISER RESILIENT SUPPORT

A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch- (13-mm-) thick neoprene.

1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
2. Maximum Load Per Support: 500 psig (3.45 MPa) on isolation material providing equal isolation in all directions.

2.10 RESILIENT PIPE GUIDES

A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch- (13-mm-) thick neoprene.

1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.11 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Ace Mountings Co., Inc.
    b. California Dynamics Corporation.
    c. Isolation Technology, Inc.
    d. Kinetics Noise Control, Inc.
    e. Mason Industries, Inc.
    f. Vibration Eliminator Co., Inc.

g. Vibration Mountings & Controls, Inc.

2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.12 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ace Mountings Co., Inc.
b. California Dynamics Corporation.
c. Kinetics Noise Control, Inc.
d. Mason Industries, Inc.
e. Vibration Eliminator Co., Inc.
f. Vibration Isolation.
g. Vibration Mountings & Controls, Inc.

2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
9. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 VIBRATION CONTROL DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

END OF SECTION 220548.13

SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Valve tags.
5. Warning tags.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch (0.8-mm); stainless steel, 0.025-inch (0.64-mm); aluminum, 0.032-inch (0.8-mm); or anodized aluminum, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Letter Color: Black.

3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
4. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
5. Fasteners: Stainless-steel rivets or self-tapping screws.
6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
2. Letter Color: Black.
3. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
5. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
6. Fasteners: Stainless-steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.02 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information plus emergency notification instructions.

2.03 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping

2.04 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.

1. Tag Material: Brass, 0.032-inch (0.8-mm); stainless steel, 0.025-inch (0.64-mm); aluminum, 0.032-inch (0.8-mm); or anodized aluminum, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link chain or beaded chain.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or

modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.05 WARNING TAGS

A. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches (75 by 133 mm) minimum.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Safety yellow background with black lettering.

PART 3 - EXECUTION

3.01 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.03 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.04 PIPE LABEL INSTALLATION

A. Piping Color Coding: Painting of piping is specified in Section 099123 "Interior Painting."

B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 25 feet (7.6 m) o.c. along each run. Reduce intervals to 10 feet (3 m) o.c. in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Install pipe labels at a 45-deg angle down from horizontal on both sides of piping to permit view from under and side of piping.

C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

D. Pipe Label Color Schedule:

1. Low-Pressure Compressed Air Piping:

   a. Background: Safety blue.
   b. Letter Colors: White.

2. High-Pressure Compressed Air Piping:

   a. Background: Safety blue.
   b. Letter Colors: White.

3. Domestic Water Piping

   a. Background: Safety green.
   b. Letter Colors: White.

4. Sanitary Waste and Storm Drainage Piping:

   a. Background Color: Safety white.
   b. Letter Color: Black.

3.05 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, fixture stop valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

   a. Cold Water: 1-1/2 inches (38 mm), round.
   b. Hot Water: 1-1/2 inches (38 mm), round.
   c. Low-Pressure Compressed Air: 1-1/2 inches (38 mm), round.
   d. High-Pressure Compressed Air: 1-1/2 inches (38 mm), round.

2. Valve-Tag Colors:

   a. Cold Water: Natural.
   b. Hot Water: Natural.
   c. Low-Pressure Compressed Air: Natural.
   d. High-Pressure Compressed Air: Natural.

3. Letter Colors:

   a. Cold Water: White.
   b. Hot Water: White.
   c. Low-Pressure Compressed Air: White.
   d. High-Pressure Compressed Air: White.

3.06 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 220553

SECTION 22 07 16 - PLUMBING EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes insulating the following plumbing equipment:

1. Domestic water boiler breechings.
2. Domestic water heat exchangers.
3. Domestic water converters.
4. Domestic water, hot-water and chilled-water pumps.
5. Domestic water storage tanks.
6. Domestic water filter housings.

B. Related Sections:

1. Section 220719 "Plumbing Piping Insulation."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied, if any).

1.4 INFORMATIONAL SUBMITTALS

A. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

1.5 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with equipment Installer for equipment insulation application.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Domestic Water Boiler Breeching Insulation Schedule" and "Equipment Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Calcium Silicate:

1. Products: Subject to compliance with requirements, provide the following:

a. Industrial Insulation Group (IIG); Thermo-12 Gold.

2. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.

G. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide the following:

a. Pittsburgh Corning Corporation; Foamglas.

2. Block Insulation: ASTM C 552, Type I.
3. Special-Shaped Insulation: ASTM C 552, Type III.
4. Board Insulation: ASTM C 552, Type IV.
5. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

H. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Products: Subject to compliance with requirements, provide the following:

a. Aeroflex USA, Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.
c. K-Flex USA; Insul-Sheet and K-FLEX LS.

I. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide the following:

a. CertainTeed Corp.; SoftTouch Duct Wrap.
b. Johns Manville; Microlite.
c. Knauf Insulation; Friendly Feel Duct Wrap.
d. Manson Insulation Inc.; Alley Wrap.
e. Owens Corning; SOFTR All-Service Duct Wrap.

J. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.

1. Products: Subject to compliance with requirements, provide the following:

   a. Industrial Insulation Group (IIG); MinWool-1200 Flexible Batt.
   b. Johns Manville; HTB 26 Spin-Glas.
   c. Roxul Inc.; Roxul RW.

K. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide the following:

   a. CertainTeed Corp.; CertaPro Commercial Board.
   b. Fibrex Insulations Inc.; FBX.
   c. Johns Manville; 800 Series Spin-Glas.
   d. Knauf Insulation; Insulation Board.
   e. Manson Insulation Inc.; AK Board.
   f. Owens Corning; Fiberglas 700 Series.

L. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type III, without factory-applied jacket.

1. Products: Subject to compliance with requirements, provide the following:

   a. Fibrex Insulations Inc.; FBX.
   b. Industrial Insulation Group (IIG); MinWool-1200 Industrial Board.
   c. Rock Wool; Delta Board.
   d. Roxul Inc.; RHT and RockBoard.
   e. Thermafiber, Inc.; Thermafiber Industrial Felt.

M. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide the following:

   a. Fibrex Insulations Inc.; Coreplus 1200.
   b. Johns Manville; Micro-Lok.
   c. Knauf Insulation; 1000-Degree Pipe Insulation.
   d. Manson Insulation Inc.; Alley-K.
   e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 Deg F (454 Deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

N. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or

less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide the following:

   a. CertainTeed Corp.; CrimpWrap.
   b. Johns Manville; MicroFlex.
   c. Knauf Insulation; Pipe and Tank Insulation.
   d. Manson Insulation Inc.; AK Flex.
   e. Owens Corning; Fiberglas Pipe and Tank Insulation.

O. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

1. Products: Subject to compliance with requirements, provide the following:

   a. Armacell LLC; Tubolit.
   b. Nomaco Insulation; IMCOLOCK, IMCOSHEET, NOMALOCK, and NOMAPLY.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F (10 to 427 deg C).

C. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F (minus 73 to plus 93 deg C).

D. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

E. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

F. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

G. PVC Jacket Adhesive: Compatible with PVC jacket.

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
3. Solids Content: 60 percent by volume and 66 percent by weight.
4. Color: White.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.

1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over insulation.
2. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).
3. Color: White.

2.6 SEALANTS

A. Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
4. Color: White or gray.

B. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.

3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: Aluminum.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: White.

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. PVDC Jacket for Indoor Applications: 4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm (0.013 metric perm) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
5. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm (0.007 metric perm) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
6. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.
2. Color: White.
3. Factory-fabricated tank heads and tank side panels.

C. Metal Jacket:

1. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.
   a. Finish and thickness are indicated in field-applied jacket schedules.
   b. Moisture Barrier for Indoor Applications: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper.
   c. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.

2. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
   a. Material, finish, and thickness are indicated in field-applied jacket schedules.
   b. Moisture Barrier for Indoor Applications: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper.
   c. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Width: 3 inches (75 mm).
2. Thickness: 11.5 mils (0.29 mm).
3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Width: 3 inches (75 mm).
2. Thickness: 6.5 mils (0.16 mm).
3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches (50 mm).
2. Thickness: 6 mils (0.15 mm).
3. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches (50 mm).
2. Thickness: 3.7 mils (0.093 mm).

3. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

E. PVDC Tape: White vapor-retarder PVDC tape with acrylic adhesive.

1. Width: 3 inches (75 mm).
2. Film Thickness: 4 mils (0.10 mm).
3. Adhesive Thickness: 1.5 mils (0.04 mm).
4. Elongation at Break: 145 percent.
5. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.

2.10 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) wide with wing seal or closed seal.
2. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) wide with wing seal or closed seal.
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

    a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
    b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
    c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

a. Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.
b. Spindle: Nylon, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).
c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
c. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

D. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel.

2.11 CORNER ANGLES

A. PVC Corner Angles: 30 mils (0.8 mm) thick, minimum 1 by 1 inch (25 by 25 mm), PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch (1.0 mm) thick, minimum 1 by 1 inch (25 by 25 mm), aluminum according to ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14.

C. Stainless-Steel Corner Angles: 0.024 inch (0.61 mm) thick, minimum 1 by 1 inch (25 by 25 mm), stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range between 140 and 300 deg F (60 and 149 deg C). Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

P. Final appearance of the completed insulation shall be a significant factor in determining acceptability of work.

3.4 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. Mineral-Fiber, Pipe, and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches (75 mm) from insulation end joints, and 16 inches (400 mm) o.c. in both directions.
    d. Do not overcompress insulation during installation.
    e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    f. Impale insulation over anchor pins and attach speed washers.
    g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches (150 mm) from

each end. Install wire or cable between two circumferential girdles 12 inches (300 mm) o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches (1200 mm) o.c. Use this network for securing insulation with tie wire or bands.

7. Stagger joints between insulation layers at least 3 inches (75 mm).
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch (150-mm) centers, starting at corners. Install 3/8-inch- (10-mm-) diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from galvanized steel, at least 0.040 inch (1.0 mm) thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.5 INSTALLATION OF CALCIUM SILICATE INSULATION

A. Insulation Installation on Domestic Water Boiler Breechings:

1. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation material.
2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.
3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

E. Where PVDC jackets are indicated, install as follows:

1. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches (850 mm) or less. 33-1/2-inch- (850-mm-) circumference limit allows for 2-inch- (50-mm-) overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
2. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.8 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.10 DOMESTIC WATER BOILER BREECHING INSULATION SCHEDULE

A. Round, exposed breeching and connector insulation shall be one of the following:

1. Calcium Silicate: 4 inches (100 mm) thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.

B. Round, concealed breeching and connector insulation shall be one of the following:

1. Calcium Silicate: 4 inches (100 mm) thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.

3. High-Temperature Mineral-Fiber Board: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.

C. Rectangular, exposed breeching and connector insulation shall be one of the following:

1. Calcium Silicate: 4 inches (100 mm) thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.

D. Rectangular, concealed breeching and connector insulation shall be one of the following:

1. Calcium Silicate: 4 inches (100 mm) thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.

3.11 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment that is not factory insulated.

C. Heat-exchanger (water-to-water for domestic water heating service) insulation shall be one of the following:

1. Calcium Silicate: 3 inches (75 mm) thick.
2. Cellular Glass: 3 inches (75 mm) thick.
3. Mineral-Fiber Blanket: 2 inches (50 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) nominal density.
4. Mineral-Fiber Board: 2 inches (50 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) nominal density.
5. Mineral-Fiber Pipe and Tank: 2 inches (50 mm) thick.
6. Mineral-Fiber Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.

D. Domestic water pump insulation shall be one of the following:

1. Cellular Glass: 2 inches (50 mm) thick.
2. Mineral-Fiber Blanket: 1 inch (25 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) nominal density.
3. Mineral-Fiber Board: 1 inch (25 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) nominal density.

E. Domestic chilled-water (potable) pump insulation shall be one of the following:

1. Cellular Glass: 3 inches (75 mm) thick.

2. Mineral-Fiber Blanket: 2 inches (50 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) nominal density.
3. Mineral-Fiber Board: 2 inches (50 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) nominal density.

F. Domestic hot-water pump insulation shall be one of the following:

1. Cellular Glass: 2 inches (50 mm) thick.
2. Mineral-Fiber Blanket: 1 inch (25 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) nominal density.
3. Mineral-Fiber Board: 1 inch (25 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) nominal density.

G. Domestic water, domestic chilled-water (potable), and domestic hot-water hydropneumatic tank insulation shall be one of the following:

1. Cellular Glass: 1-1/2 inches (38 mm) thick.
2. Flexible Elastomeric: 1 inch (25 mm) thick.
3. Mineral-Fiber Blanket: 1 inch (25 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) nominal density.
4. Mineral-Fiber Board: 1 inch (25 mm)] thick and 2-lb/cu. ft. (32-kg/cu. m) nominal density.
5. Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.
6. Polyolefin: 1 inch (25 mm) thick.

H. Domestic hot-water storage tank insulation shall be one of the following, of thickness to provide an R-value of 12.5:

1. Cellular glass.
2. Mineral-Fiber Blanket: 2-lb/cu. ft. (32-kg/cu. m) nominal density.
3. Mineral-Fiber Board: 2-lb/cu. ft. (32-kg/cu. m) nominal density.
4. Mineral-fiber pipe and tank.

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed:

1. None.
2. PVC: 20 mils (0.5 mm) thick.
3. Aluminum, Smooth: 0.016 inch (0.41 mm) thick.
4. Painted Aluminum, Smooth: 0.016 inch (0.41 mm) thick.
5. Stainless Steel, Type 304 or Type 316, Smooth 2B Finish: 0.010 inch (0.25 mm) thick.

D. Equipment, Exposed, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces up to 72 Inches (1800 mm):

1. None.
2. PVC: 20 mils (0.5 mm) thick.
3. Aluminum, Smooth: 0.016 inch (0.41 mm) thick.
4. Painted Aluminum, Smooth: 0.016 inch (0.41 mm) thick.
5. Stainless Steel, Type 304 or Type 316, Smooth 2B Finish: 0.010 inch (0.25 mm) thick.

E. Equipment, Exposed, Larger Than 48 Inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 Inches (1800 mm):

1. None.
2. Painted Aluminum, Smooth with 1-1/4-Inch- (32-mm-) Deep Corrugations thick.
3. Stainless Steel, Type 304 or Type 316, Smooth with 1-1/4-Inch- (32-mm-) Deep Corrugations thick.

3.13 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed:

1. None.
2. PVC: 20 mils (0.5 mm) thick.
3. Aluminum, Smooth: 0.016 inch (0.41 mm) thick.
4. Painted Aluminum, Smooth: 0.016 inch (0.41 mm) thick.
5. Stainless Steel, Type 304 or Type 316, Smooth 2B Finish: 0.010 inch (0.25 mm) thick.

D. Equipment, Exposed, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces up to 72 Inches (1800 mm):
1. Painted Aluminum, Smooth with 1-1/4-Inch- (32-mm-) Deep Corrugations thick.
2. Stainless Steel, Type 304 or Type 316, Smooth with 1-1/4-Inch- (32-mm-) Deep Corrugations thick.

E. Equipment, Exposed, Larger Than 48 Inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 Inches (1800 mm):
1. Painted Aluminum, Smooth with 1-1/4-Inch- (32-mm-) Deep Corrugations thick.
2. Stainless Steel, Type 304 or Type 316, Smooth with 1-1/4-Inch- (32-mm-) Deep Corrugations thick.

END OF SECTION 220716

SECTION 22 07 19 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes insulating the following plumbing piping services:

1. Domestic cold-water piping.
2. Domestic hot-water piping.
3. Domestic recirculating hot-water piping.
4. Domestic chilled-water piping for drinking fountains.
5. Sanitary waste piping exposed to freezing conditions.
6. Storm-water piping exposed to freezing conditions.
7. Roof drains and rainwater leaders.
8. Supplies and drains for handicap-accessible lavatories and sinks.

B. Related Sections:

1. Section 220716 "Plumbing Equipment Insulation."

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).

1.04 INFORMATIONAL SUBMITTALS

A. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

1.05 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive,

mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

B. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.07 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.08 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide the following:

    a. Pittsburgh Corning Corporation; Foamglas.

2. Block Insulation: ASTM C 552, Type I.
3. Special-Shaped Insulation: ASTM C 552, Type III.
4. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
5. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. CertainTeed Corp.; SoftTouch Duct Wrap.
    b. Johns Manville; Microlite.
    c. Knauf Insulation; Friendly Feel Duct Wrap.
    d. Manson Insulation Inc.; Alley Wrap.
    e. Owens Corning; SOFTR All-Service Duct Wrap.

H. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Fibrex Insulations Inc.; Coreplus 1200.
    b. Johns Manville; Micro-Lok.
    c. Knauf Insulation; 1000-Degree Pipe Insulation.
    d. Manson Insulation Inc.; Alley-K.
    e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 Deg F (454 Deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.02 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

2.03 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F (minus 73 to plus 93 deg C).

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

E. Phenolic Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F (minus 59 to plus 149 deg C).

F. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

G. PVC Jacket Adhesive: Compatible with PVC jacket.

2.04 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
3. Solids Content: 60 percent by volume and 66 percent by weight.
4. Color: White.

2.05 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.

1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
2. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).
3. Color: White.

2.06 SEALANTS

A. Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
4. Color: White or gray.

B. ASJ Flashing Sealants, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: White.

2.07 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.08 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Johns Manville; Zeston.
b. P.I.C. Plastics, Inc.; FG Series.

c. Proto Corporation; LoSmoke.
d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

C. Weatherproof Jacket: Self-healing, flexible weather-proofing jacket.

1. Products: Subject to compliance with requirements, provide the following:

a. Polyguard Products, Inc.; Alumaguard

D. Underground Direct-Buried Jacket: 125-mil- (3.2-mm-) thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Pittsburgh Corning Corporation; Pittwrap.
b. Polyguard Products, Inc.; Insulrap No Torch 125.

2.09 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Width: 3 inches (75 mm).
2. Thickness: 11.5 mils (0.29 mm).
3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches (50 mm).
2. Thickness: 6 mils (0.15 mm).
3. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

2.010 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) wide with wing seal.

B. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
3. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

Q. Final appearance of the completed insulation shall be a significant factor in determining acceptability of work.

3.04 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.05 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the

connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.06 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.07 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.08 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

B. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer.

3.09 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.010 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. NPS 3/4 (DN 20) and Smaller: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.

2. NPS 1 (DN 25) and Larger: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

B. Domestic Hot and Recirculated Hot Water:

1. NPS 1/2 (DN 13) and Smaller: Insulation shall be the following:

   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.

2. NPS 3/4 (DN 20) and Larger: Insulation shall be the following:

   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

C. Domestic Chilled Water (Potable):

1. All Pipe Sizes: Insulation shall be the following:

   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

D. Stormwater and Overflow:

1. All Pipe Sizes: Insulation shall be the following:

   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

E. Roof Drain and Overflow Drain Bodies:

1. All Pipe Sizes: Insulation shall be one of the following:

   a. Mineral-Fiber: 2 inches (50 mm) thick.
   b. Cellular glass: 2 inches (50 mm) thick.

F. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

1. See Plumbing Fixture Schedule on plans.

G. Sanitary Waste Piping Where Heat Tracing Is Installed:

1. All Pipe Sizes: Insulation shall be the following:

   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches (38 mm) thick.

H. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet (3 m) of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):

1. All Pipe Sizes: Insulation shall be the following:

   Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.

I. Hot Service Drains:

1. All Pipe Sizes: Insulation shall be the following:

   a. Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch (25 mm) thick.

J. Hot Service Vents:

1. All Pipe Sizes: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch (25 mm) thick.

3.011 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Domestic Water Piping:

1. All Pipe Sizes: Insulation shall be the following:

a. Cellular Glass: 2 inches (50 mm) thick.

B. Domestic Hot and Recirculated Hot Water:

1. All Pipe Sizes: Insulation shall be the following:

a. Cellular Glass: 2 inches (50 mm) thick.

C. Sanitary Waste Piping Where Heat Tracing Is Installed:

1. All Pipe Sizes: Insulation shall be the following:

a. Cellular Glass: 2 inches (50 mm) thick.

D. Hot Service Drains:

1. All Pipe Sizes: Insulation shall be the following:

a. Cellular Glass: 2 inches (50 mm) thick.

E. Hot Service Vents:

1. All Pipe Sizes: Insulation shall be the following:

a. Cellular Glass: 2 inches (50 mm) thick.

3.012 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Piping, Concealed:

1. None.

C. Piping, Exposed To View In Public Spaces:

1. PVC: 30 mils (0.8 mm) thick.

3.013 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Piping, All:

1. Alumaguard, flexible weather-proofing jacket.

3.014 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 220719

SECTION 22 11 16 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.
2. Encasement for piping.
3. Transition fittings.
4. Dielectric fittings.

B. Related Requirements:

1. Section 221113 "Facility Water Distribution Piping" for water-service piping outside the building from source to the point where water-service piping enters the building.

1.03 ACTION SUBMITTALS

A. Product Data: For transition fittings and dielectric fittings.

1.04 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

B. Field quality-control reports.

1.05 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of water service.
2. Do not interrupt water service without Owner's written permission.

1.06 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for installations.

B. Coordinate requirements for access panels and doors for items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."

C. Comply with NSF 372 for low lead.

2.02 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) water tube, drawn temper.

B. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) water tube, annealed temper.

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

F. Copper Unions:

1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

2.03 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Standard-Pattern, Mechanical-Joint Fittings:

1. AWWA C110/A21.10, ductile or gray iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.04 PEX TUBE AND FITTINGS

A. Tube Material: PEX plastic according to ASTM F 876 and ASTM F 877.

B. Fittings for PEX Tube: ASTM F 1807, metal-insert type with copper or stainless-steel crimp rings and matching PEX tube dimensions.

C. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F 876; with plastic or corrosion-resistant-metal valve for each outlet.

2.05 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.06 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105/A21.5.

B. Form: Sheet or tube.

C. Color: Black or natural.

2.07 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

2.08 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Standard: ASSE 1079.
2. Pressure Rating: 150 psig (1035 kPa).
3. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Standard: ASSE 1079.
2. Factory-fabricated, bolted, companion-flange assembly.
3. Pressure Rating: 150 psig (1035 kPa).
4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Nonconducting materials for field assembly of companion flanges.
2. Pressure Rating: 150 psig (1035 kPa).
3. Gasket: Neoprene or phenolic.
4. Bolt Sleeves: Phenolic or polyethylene.
5. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Standard: IAPMO PS 66.
2. Electroplated steel nipple complying with ASTM F 1545.
3. Pressure Rating and Temperature: 300 psig (2070 kPa) at 225 deg F (107 deg C).
4. End Connections: Male threaded or grooved.
5. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.01 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.02 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105/A21.5.

E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."

F. Install shutoff valve immediately upstream of each dielectric fitting.

G. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."

H. Install domestic water piping level without pitch and plumb.

I. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

J. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

K. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

M. Install piping to permit valve servicing.

N. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

O. Install piping free of sags and bends.

P. Install fittings for changes in direction and branch connections.

Q. Install PEX tubing with loop at each change of direction of more than 90 degrees.

R. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

S. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping."

T. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123 "Domestic Water Pumps."

U. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."

V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.03 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Joints for PEX Tubing: Join according to ASTM F 1807 for metal insert and copper crimp ring fittings and ASTM F 1960 for cold expansion fittings and reinforcing rings.

H. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.04 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. Fittings for NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
2. Fittings for NPS 2 (DN 50) and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings or unions.

3.05 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric couplings or nipples.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric nipples.

D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.06 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.

2. Individual, Straight, Horizontal Piping Runs:

    a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch (10 mm).

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
4. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
5. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
6. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.

E. Install supports for vertical copper tubing every 10 feet (3 m).

F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 (DN 32) and Smaller: 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
5. NPS 3 and NPS 3-1/2 (DN 80 and DN 90): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
7. NPS 6 (DN 150): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
8. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.

G. Install supports for vertical steel piping every 15 feet (4.5 m).

H. Install vinyl-coated hangers for PEX piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1 (DN 25) and Smaller: 32 inches (815 mm) with 3/8-inch (10-mm) rod.

I. Install hangers for vertical PEX piping every 48 inches (1200 mm).

J. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.07 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

3.08 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Label pressure piping with system operating pressure.

3.09 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.

2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
d. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.010 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.

7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.011 CLEANING

A. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

B. Protect piping during construction period to avoid clogging with dirt and debris and to prevent damage from construction work.

C. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Fill and isolate system according to either of the following:

        1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Open fixtures as necessary to introduce solution to the entire domestic piping system. Isolate with valves and allow to stand for 24 hours.

    c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    d. Submit water samples in sterile bottles to authorities having jurisdiction.
    e. Repeat procedures if biological examination shows contamination.

D. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

3.012 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Under-building-slab, domestic water, building-service piping, NPS 3 (DN 80) and smaller, shall be the following:

1. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A); wrought-copper, solder-joint fittings; and brazed joints.

D. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 (DN 100 to DN 200) and larger, shall be one of the following:

1. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A); wrought-copper, solder-joint fittings; and brazed joints.
2. Mechanical-joint, ductile-iron pipe; standard-pattern, mechanical-joint fittings; and mechanical (restrained) joints.

E. Under-building-slab, domestic water piping, NPS 2 (DN 50) and smaller, shall be the following:

1. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A); wrought-copper, solder-joint fittings; and brazed joints.

F. Aboveground domestic water piping, NPS 2 (DN 50) and smaller, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast- or wrought-copper, solder-joint fittings; and soldered joints.
2. PEX tube, NPS 1 (DN 25) and smaller; fittings for PEX tube; and crimped joints.

G. Aboveground domestic water piping, NPS 2-1/2 to NPS 8 (DN 65 to DN 200), shall be the following:

1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast- or wrought-copper, solder-joint fittings; and brazed joints.

3.013 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball or gate valves for piping NPS 2 (DN 50) and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
2. Throttling Duty: Use ball or globe valves for piping NPS 2 (DN 50) and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
3. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 221116

SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Automatic water shutoff valves.
5. Balancing valves.
6. Temperature-actuated, water mixing valves.
7. Strainers.
8. Outlet boxes.
9. Hose stations.
10. Hose bibbs.
11. Wall hydrants.
12. Ground hydrants.
13. Post hydrants.
14. Drain valves.
15. Water-hammer arresters.
16. Trap-seal primer valves.
17. Trap-seal primer systems.
18. Specialty valves.
19. Flexible connectors.
20. Water meters.

B. Related Requirements:

1. Section 220519 "Meters and Gauges for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
2. Section 221116 "Domestic Water Piping" for water meters.
3. Section 223200 "Domestic Water Filtration Equipment" for water filters in domestic water piping.
4. Section 224300 "Medical Plumbing Fixtures" for thermostatic mixing valves for sitz baths, thermostatic mixing-valve assemblies for hydrotherapy equipment, and outlet boxes for dialysis equipment.
5. Section 224500 "Emergency Plumbing Fixtures" for water tempering equipment.
6. Section 224713 "Drinking Fountains" for water filters for water coolers.
7. Section 224716 "Pressure Water Coolers" for water filters for water coolers.

8. Section 224723 "Remote Water Coolers" for water filters for water coolers.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For domestic water piping specialties.

1. Include diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61 and NSF 14. Mark "NSF-pw" on plastic piping components.

B. Comply with NSF 372 for low lead.

2.02 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa) unless otherwise indicated.

2.03 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Conbraco Industries, Inc.
b. FEBCO; a division of Watts Water Technologies, Inc.
c. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.

d. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 3 (DN 8 to DN 80), as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Rough bronze.

B. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Conbraco Industries, Inc.
b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
c. Woodford Manufacturing Company; a division of WCM Industries, Inc.
d. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
e. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1011.
3. Body: Bronze, nonremovable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or nickel plated.

C. Pressure Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Conbraco Industries, Inc.
b. FEBCO; a division of Watts Water Technologies, Inc.
c. Flomatic Corporation.
d. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
e. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig (35 kPa) maximum, through middle third of flow range.
5. Size: Match pipe size.
6. Accessories: Valves: Ball type, on inlet and outlet.

D. Laboratory-Faucet Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Conbraco Industries, Inc.
b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
c. Woodford Manufacturing Company; a division of WCM Industries, Inc.
d. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1035.
3. Size: NPS 1/4 or NPS 3/8 (DN 8 or DN 10) matching faucet size.
4. Body: Bronze.
5. End Connections: Threaded.
6. Finish: Chrome plated.

E. Spill-Resistant Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Conbraco Industries, Inc.
b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.

2. Standard: ASSE 1056.
3. Operation: Continuous-pressure applications.
4. Accessories: Valves: Ball type, on inlet and outlet.

2.04 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Conbraco Industries, Inc.
b. FEBCO; a division of Watts Water Technologies, Inc.
c. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
d. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1012.
3. Operation: Continuous-pressure applications.
4. Size: NPS 1/2 (DN 15) NPS 3/4 (DN 20).
5. Body: Bronze.
6. End Connections: Union, solder joint.
7. Finish: Chrome plated.

B. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Conbraco Industries, Inc.
    b. FEBCO; a division of Watts Water Technologies, Inc.
    c. Flomatic Corporation.
    d. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
    e. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig (83 kPa) maximum, through middle third of flow range.
5. Size: Match pipe size.
6. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, or stainless steel, for NPS 2-1/2 (DN 65) and larger.
7. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
8. Configuration: Designed for horizontal, straight-through flow.
9. Accessories:

    a. Valves NPS 2 (DN 50) and Smaller: Ball type with threaded ends on inlet and outlet.
    b. Valves NPS 2-1/2 (DN 65) and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
    c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

C. Double-Check, Backflow-Prevention Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Conbraco Industries, Inc.
    b. FEBCO; a division of Watts Water Technologies, Inc.
    c. Flomatic Corporation.
    d. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
    e. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1015.
3. Operation: Continuous-pressure applications unless otherwise indicated.
4. Pressure Loss: 5 psig (35 kPa) maximum, through middle third of flow range.
5. Size: Match pipe size.
6. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, or stainless steel, for NPS 2-1/2 (DN 65) and larger.

7. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
8. Configuration: Designed for horizontal, straight-through flow.
9. Accessories:

    a. ValvesNPS 2 (DN 50) and Smaller: Ball type with threaded ends on inlet and outlet.
    b. ValvesNPS 2-1/2 (DN 65) and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.

D. Beverage-Dispensing-Equipment Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Conbraco Industries, Inc.
    b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
    c. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1022.
3. Operation: Continuous-pressure applications.
4. Size: NPS 1/4 or NPS 3/8 (DN 8 or DN 10).
5. Body: Stainless steel.
6. End Connections: Threaded.

E. Dual-Check-Valve Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Conbraco Industries, Inc.
    b. FEBCO; a division of Watts Water Technologies, Inc.
    c. Flomatic Corporation.
    d. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
    e. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1024.
3. Operation: Continuous-pressure applications.
4. Size: NPS 1/2 (DN 15) NPS 3/4 (DN 20) NPS 1 (DN 25) NPS 1-1/4 (DN 32).
5. Body: Bronze with union inlet.

F. Carbonated-Beverage-Dispenser, Dual-Check-Valve Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.

2. Standard: ASSE 1032.
3. Operation: Continuous-pressure applications.
4. Size: NPS 1/4 or NPS 3/8 (DN 8 or DN 10).
5. Body: Stainless steel.
6. End Connections: Threaded.

G. Reduced-Pressure-Detector, Fire-Protection, Backflow-Preventer Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Conbraco Industries, Inc.
b. FEBCO; a division of Watts Water Technologies, Inc.
c. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
d. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1047 and is FM Global approved or UL listed.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig (83 kPa) maximum, through middle third of flow range.
5. Size: Match pipe size.
6. Body: Cast iron with interior lining that complies with AWWA C550 or that is FDA approved, or stainless steel.
7. End Connections: Flanged.
8. Configuration: Designed for horizontal, straight-through flow.
9. Accessories:

a. Valves: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
c. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

H. Double-Check, Detector-Assembly Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Conbraco Industries, Inc.
b. FEBCO; a division of Watts Water Technologies, Inc.
c. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
d. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1048 and is FM Global approved or UL listed.
3. Operation: Continuous-pressure applications.

4. Pressure Loss: 5 psig (35 kPa) maximum, through middle third of flow range.
5. Size: Match pipe size.
6. Body: Cast iron with interior lining that complies with AWWA C550 or that is FDA approved, or stainless steel.
7. End Connections: Flanged.
8. Configuration: Designed for horizontal, straight-through flow.
9. Accessories:

    a. Valves: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
    b. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

I. Hose-Connection Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Conbraco Industries, Inc.
    b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
    c. Woodford Manufacturing Company; a division of WCM Industries, Inc.

2. Standard: ASSE 1052.
3. Operation: Up to 10-foot head of water (30-kPa) back pressure.
4. Inlet Size: NPS 1/2 or NPS 3/4 (DN 15 or DN 20).
5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
6. Capacity: At least 3-gpm (0.19-L/s) flow.

2.05 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Conbraco Industries, Inc.
    b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
    c. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig (1035 kPa).
4. Size: Match pipe size.
5. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).
6. Valves for Booster Heater Water Supply: Include integral bypass.

7. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).

B. Water-Control Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Flomatic Corporation.
   b. Watts; a division of Watts Water Technologies, Inc.; Control Valves (Watts ACV).
   c. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Description: Pilot-operated, diaphragm-type, single-seated, main water-control valve.
3. Pressure Rating: Initial working pressure of 150 psig (1035 kPa) minimum with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot-control valve, restrictor device, specialty fittings, and sensor piping.
4. Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.

   a. Size: Match pipe size.
   b. Pattern: Angle-valve design.
   c. Trim: Stainless steel.

5. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.

2.06 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Armstrong International, Inc.
   b. Flo Fab Inc.
   c. ITT Corporation; Bell & Gossett Div.
   d. NIBCO Inc.
   e. TAC.
   f. TACO Incorporated.
   g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.

2. Type: Ball or Y-pattern globe valve with two readout ports and memory-setting indicator.
3. Body: Brass or bronze.
4. Size: Same as connected piping, but not larger than NPS 2 (DN 50).

5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

B. Cast-Iron Calibrated Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Armstrong International, Inc.
   b. Flo Fab Inc.
   c. ITT Corporation; Bell & Gossett Div.
   d. NIBCO Inc.
   e. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.

2. Type: Adjustable with Y-pattern globe valve, two readout ports, and memory-setting indicator.
3. Size: Same as connected piping, but not smaller than NPS 2-1/2 (DN 65).

C. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

D. Memory-Stop Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Conbraco Industries, Inc.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Crane Co.; Crane Valve Group; Jenkins Valves.
   d. Crane Co.; Crane Valve Group; Stockham Div.
   e. Hammond Valve.
   f. Milwaukee Valve Company.
   g. NIBCO Inc.
   h. Red-White Valve Corp.

2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
3. Pressure Rating: 400-psig (2760-kPa) minimum CWP.
4. Size: NPS 2 (DN 50) or smaller.
5. Body: Copper alloy.
6. Port: Standard or full port.
7. Ball: Chrome-plated brass.
8. Seats and Seals: Replaceable.
9. End Connections: Solder joint or threaded.
10. Handle: Vinyl-covered steel with memory-setting device.

2.07 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Water-Temperature Limiting Devices:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Armstrong International, Inc.
    b. Conbraco Industries, Inc.
    c. Leonard Valve Company.
    d. Powers; a division of Watts Water Technologies, Inc.
    e. Symmons Industries, Inc.
    f. TACO Incorporated.
    g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
    h. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig (860 kPa).
4. Type: Thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Finish: Chrome plated.

B. Primary, Thermostatic, Water Mixing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Armstrong International, Inc.
    b. Lawler Manufacturing Company, Inc.
    c. Leonard Valve Company.
    d. Powers; a division of Watts Water Technologies, Inc.
    e. Symmons Industries, Inc.

2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig (860 kPa)minimum unless otherwise indicated.
4. Type: Exposed-mounted, thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Finish: Chrome plated.
9. Piping Finish: Chrome plated.

C. Manifold, Thermostatic, Water Mixing-Valve Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Leonard Valve Company.
    b. Powers; a division of Watts Water Technologies, Inc.

c. Symmons Industries, Inc.

2. Description: Factory-fabricated, exposed-mounted, thermostatically controlled, water mixing-valve assembly in two-valve parallel arrangement.
3. Large-Flow Parallel: Thermostatic, water mixing valve and downstream-pressure regulator with pressure gages on inlet and outlet.
4. Small-Flow Parallel: Thermostatic, water mixing valve.
5. Thermostatic Mixing Valves: Comply with ASSE 1017. Include check stops on hot- and cold-water inlets and shutoff valve on outlet.
6. Water Regulator(s): Comply with ASSE 1003. Include pressure gage on inlet and outlet.
7. Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
8. Thermostatic Mixing Valve and Water Regulator Finish: Chrome plated.
9. Piping Finish: Chrome plated.

D. Individual-Fixture, Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Conbraco Industries, Inc.
   b. Lawler Manufacturing Company, Inc.
   c. Leonard Valve Company.
   d. Powers; a division of Watts Water Technologies, Inc.
   e. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   f. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1016, thermostatically controlled, water tempering valve.
3. Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
4. Body: Bronze body with corrosion-resistant interior components.
5. Temperature Control: Adjustable.
6. Inlets and Outlet: Threaded.
7. Finish: Rough or chrome-plated bronze.
8. Tempered-Water Setting: 110 deg F (43 deg C).

E. Primary Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Heat-Timer Corporation.
   b. Holby Valve Co., Inc.

2. Standard: ASSE 1017, thermostatically controlled, water tempering valve, listed as tempering valve.
3. Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
4. Body: Bronze.
5. Temperature Control: Manual.
6. Inlets and Outlet: Threaded.

7. Valve Finish: Rough bronze.

2.08 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 (DN 65) and larger.
3. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:

    a. Strainers NPS 2 (DN 50) and Smaller: 0.020 inch (0.51 mm).
    b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.045 inch (1.14 mm).
    c. Strainers NPS 5 (DN 125) and Larger: 0.10 inch (2.54 mm).

6. Drain: Pipe plug.

2.09 OUTLET BOXES

A. Clothes Washer Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Acorn Engineering Company.
    b. Guy Gray Manufacturing Co., Inc.
    c. IPS Corporation.
    d. Oatey.
    e. Symmons Industries, Inc.
    f. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
    g. Whitehall Manufacturing; a div. of Acorn Engineering Company.
    h. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.

2. Mounting: Recessed.
3. Material and Finish: Enameled-steel or epoxy-painted-steel box and faceplate.
4. Faucet: Combination valved fitting or separate hot- and cold-water valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
5. Supply Shutoff Fittings: NPS 1/2 (DN 15) gate, globe, or ball valves and NPS 1/2 (DN 15) copper, water tubing.
6. Drain: NPS 2 (DN 50) standpipe and P-trap for direct waste connection to drainage piping.

B. Icemaker Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Acorn Engineering Company.
    b. Guy Gray Manufacturing Co., Inc.
    c. IPS Corporation.
    d. Oatey.
    e. Symmons Industries, Inc.
    f. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
    g. Whitehall Manufacturing; a div. of Acorn Engineering Company.
    h. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.

2. Mounting: Recessed.
3. Material and Finish: Enameled-steel or epoxy-painted-steel box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 (DN 15) or smaller copper tube outlet.
5. Supply Shutoff Fitting: NPS 1/2 (DN 15) gate, globe, or ball valve and NPS 1/2 (DN 15) copper, water tubing.

2.010 HOSE STATIONS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Leonard Valve Company.
2. T & S Brass.

B. Single-Temperature-Water Hose Stations:

1. Standard: ASME A112.18.1.
2. Cabinet: Stainless-steel enclosure with exposed valve handle, hose connection, and hose rack. Include thermometer in front.
3. Hose-Rack Material: Stainless steel.
4. Body Material: Bronze with stainless-steel wetted parts.
5. Body Finish: Rough bronze, chrome plated.
6. Mounting: Wall, with reinforcement.
7. Supply Fittings: NPS 1/2 (DN 15) NPS 3/4 (DN 20) gate, globe, or ball valve and check valve and NPS 1/2 (DN 15) NPS 3/4 (DN 20) copper, water tubing. Omit check valve if check stop is included with fitting.
8. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; 25 feet (7.6 m) long.
9. Nozzle: With hand-squeeze, on-off control.
10. Vacuum Breaker:

    a. Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
    b. Garden-hose thread complying with ASME B1.20.7 on outlet.

C. Hot- and Cold-Water Hose Stations:

1. Standard: ASME A112.18.1.
2. Faucet Type: Thermostatic mixing valve.
3. Cabinet: Stainless-steel enclosure with exposed valve handles, hose connection, and hose rack. Include thermometer in front.
4. Hose-Rack Material: Stainless steel.
5. Body Material: Bronze with stainless-steel wetted parts.
6. Body Finish: Rough bronze or chrome plated.
7. Mounting: Wall, with reinforcement.
8. Supply Fittings: Two NPS 1/2 (DN 15) NPS 3/4 (DN 20) gate, globe, or ball valves and check valves and NPS 1/2 (DN 15) NPS 3/4 (DN 20) copper, water tubing. Omit check valves if check stops are included with fitting.
9. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; 25 feet (7.6 m) long.
10. Nozzle: With hand-squeeze, on-off control.
11. Vacuum Breaker: Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052; and garden-hose thread complying with ASME B1.20.7 on outlet.

2.011 HOSE BIBBS

A. Hose Bibbs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Josam Company.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products.
   f. Woodford Manufacturing Company; a division of WCM Industries, Inc.
   g. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
   h. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.

2. Standard: ASME A112.18.1 for sediment faucets.
3. Body Material: Bronze.
4. Seat: Bronze, replaceable.
5. Pressure Rating: 125 psig (860 kPa).
6. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
7. See plumbing fixture schedule on plans for more information.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.

12. Operation for Service Areas: Operating key.
13. Operation for Finished Rooms: Operating key.
14. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.012 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Josam Company.
    b. MIFAB, Inc.
    c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    d. Tyler Pipe; Wade Div.
    e. Watts Drainage Products.
    f. Woodford Manufacturing Company; a division of WCM Industries, Inc.
    g. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
    h. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.

2. Standard: ASME A112.21.3M for self-draining wall hydrants.
3. Pressure Rating: 125 psig (860 kPa).
4. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
5. See plumbing fixture schedule on plans for more information.

B. Nonfreeze, Hot- and Cold-Water Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Josam Company.
    b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    c. Tyler Pipe; Wade Div.
    d. Watts Drainage Products.
    e. Woodford Manufacturing Company; a division of WCM Industries, Inc.
    f. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.

2. Standard: ASME A112.21.3M for self-draining wall hydrants.
3. Pressure Rating: 125 psig (860 kPa).
4. Casing and Operating Rods: Of length required to match wall thickness. Include wall clamps.
5. See plumbing fixture schedule on plans for more information.

2.013 GROUND HYDRANTS

A. Nonfreeze Ground Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Josam Company.
    b. MIFAB, Inc.
    c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    d. Tyler Pipe; Wade Div.
    e. Watts Drainage Products.
    f. Woodford Manufacturing Company; a division of WCM Industries, Inc.
    g. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
    h. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.

2. Standard: ASME A112.21.3M.
3. Type: Nonfreeze, concealed-outlet ground hydrant with box.
4. Operation: Loose key.
5. Casing and Operating Rod: Of at least length required for burial of valve below frost line.
6. Inlet: NPS 3/4 (DN 20).
7. Outlet: Garden-hose thread complying with ASME B1.20.7.
8. Drain: Designed with hole to drain into ground when shut off.
9. Box: Standard pattern with cover.
10. Box and Cover Finish: Rough bronze.
11. Operating Key(s): One with each ground hydrant.
12. Vacuum Breaker: ASSE 1011.

2.014 POST HYDRANTS

A. Nonfreeze, Draining-Type Post Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. MIFAB, Inc.
    b. Simmons Manufacturing Co.
    c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    d. Tyler Pipe; Wade Div.
    e. Watts Drainage Products.
    f. Woodford Manufacturing Company; a division of WCM Industries, Inc.
    g. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
    h. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.

2. Standard: ASME A112.21.3M.
3. Type: Nonfreeze, exposed-outlet post hydrant.
4. Operation: Loose key.
5. Casing and Operating Rod: Of at least length required for burial of valve below frost line.
6. Casing: Bronze with casing guard.

7. Inlet: NPS 3/4 (DN 20).
8. Outlet: Garden-hose thread complying with ASME B1.20.7.
9. Drain: Designed with hole to drain into ground when shut off.
10. Vacuum Breaker:

    a. Nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
    b. Garden-hose thread complying with ASME B1.20.7 on outlet.

11. Operating Key(s): One with each loose-key-operation wall hydrant.

B. Freeze-Resistant Sanitary Yard Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Hoeptner Products.

2. Standard: ASSE 1057, Type 5 for nondraining hydrants.
3. Operation: Wheel handle.
4. Head: Copper alloy, with pail hook.
5. Inlet: NPS 3/4-inch (DN 20) threaded inlet and inlet nozzle, galvanized-steel riser, and venturi.
6. Canister: Plastic with atmospheric-vent device.
7. Vacuum Breaker:

    a. Removable hose-connection backflow preventer complying with ASSE 1052.
    b. Garden-hose thread complying with ASME B1.20.7 on outlet for field installation.

2.015 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig (2760-kPa) minimum CWP.
3. Size: NPS 3/4 (DN 20).
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Gate-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-80 for gate valves.
2. Pressure Rating: Class 125.

3. Size: NPS 3/4 (DN 20).
4. Body: ASTM B 62 bronze.
5. Inlet: NPS 3/4 (DN 20) threaded or solder joint.
6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

C. Stop-and-Waste Drain Valves:

1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: 200-psig (1380-kPa) minimum CWP or Class 125.
3. Size: NPS 3/4 (DN 20).
4. Body: Copper alloy or ASTM B 62 bronze.
5. Drain: NPS 1/8 (DN 6) side outlet with cap.

2.016 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AMTROL, Inc.
b. Josam Company.
c. MIFAB, Inc.
d. Precision Plumbing Products, Inc.
e. Sioux Chief Manufacturing Company, Inc.
f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
g. Tyler Pipe; Wade Div.
h. Watts Drainage Products.
i. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.

2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.017 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. MIFAB, Inc.
b. Precision Plumbing Products, Inc.
c. Sioux Chief Manufacturing Company, Inc.
d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
e. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.

2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig (860 kPa) minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 (DN 15) threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 (DN 15) threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

B. Drainage-Type, Trap-Seal Primer Device:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

2. Standard: ASSE 1044, lavatory P-trap with NPS 3/8 (DN 10) minimum, trap makeup connection.
3. Size: NPS 1-1/4 (DN 32) minimum.
4. Material: Chrome-plated, cast brass.

2.018 TRAP-SEAL PRIMER SYSTEMS

A. Trap-Seal Primer Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Precision Plumbing Products, Inc.

2. Standard: ASSE 1044.
3. Piping: NPS 3/4, ASTM B 88, Type L (DN 20, ASTM B 88M, Type B); copper, water tubing.
4. Cabinet: Recessed-mounted steel box with stainless-steel cover.
5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.

   a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

6. Vacuum Breaker: ASSE 1001.
7. Number Outlets: Four.
8. Size Outlets: NPS 1/2 (DN 15) NPS 5/8 (DN 18).

2.019 SPECIALTY VALVES

A. Comply with requirements for general-duty metal valves in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping,"

Section 220523.14 "Check Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."

2.020 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flex-Hose Co., Inc.
2. Flexicraft Industries.
3. Flex Pression, Ltd.
4. Flex-Weld Incorporated.
5. Hyspan Precision Products, Inc.
6. Mercer Gasket & Shim, Inc.
7. Metraflex, Inc.
8. Proco Products, Inc.
9. TOZEN Corporation.
10. Unaflex.Universal Metal Hose; a Hyspan company.

B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig (1380 kPa).
2. End Connections NPS 2 (DN 50) and Smaller: Threaded copper pipe or plain-end copper tube.
3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged copper alloy.

C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig (1380 kPa).
2. End Connections NPS 2 (DN 50) and Smaller: Threaded steel-pipe nipple.
3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

2.021 WATER METERS

A. Displacement-Type Water Meters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Badger Meter, Inc.
b. Sensus.

2. Description:

a. Standard: AWWA C700.
b. Pressure Rating: 150-psig (1035-kPa) working pressure.
c. Body Design: Nutating disc; totalization meter.

d. Registration: In gallons (liters) or cubic feet (cubic meters) as required by utility company.
e. Case: Bronze.
f. End Connections: Threaded.

B. Turbine-Type Water Meters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Badger Meter, Inc.
b. Sensus.

2. Description:

a. Standard: AWWA C701.
b. Pressure Rating: 150-psig (1035-kPa) working pressure.
c. Body Design: Turbine; totalization meter.
d. Registration: In gallons (liters) or cubic feet (cubic meters) as required by utility company.
e. Case: Bronze.
f. End Connections for Meters NPS 2 (DN 50) and Smaller: Threaded.
g. End Connections for Meters NPS 2-1/2 (DN 65) and Larger: Flanged.

C. Compound-Type Water Meters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Badger Meter, Inc.
b. Sensus.

2. Description:

a. Standard: AWWA C702.
b. Pressure Rating: 150-psig (1035-kPa) working pressure.
c. Body Design: With integral mainline and bypass meters; totalization meter.
d. Registration: In gallons (liters) or cubic feet (cubic meters) as required by utility company.
e. Case: Bronze.
f. Pipe Connections: Flanged.

D. Remote Registration System: Direct-reading type complying with AWWA C706; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

E. Remote Registration System: Encoder type complying with AWWA C707; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Backflow Preventers: Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
3. Do not install bypass piping around backflow preventers.

B. Water Regulators: Install with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.

C. Water Control Valves: Install with inlet and outlet shutoff valves and bypass with globe valve. Install pressure gages on inlet and outlet.

D. Automatic Water Shutoff Valves: Test for signal strength before valve installation. Install automatic shutoff valve downstream from main domestic water shutoff valve and downstream from fire sprinkler system supply. Install valve controller is an accessible location with sensors in areas where water is likely to accumulate.

E. Balancing Valves: Install in locations where they can easily be adjusted.

F. Temperature-Actuated, Water Mixing Valves: Install with check stops or shutoff valves on inlets and with shutoff valve on outlet.

1. Install cabinet-type units recessed in or surface mounted on wall as specified.

G. Y-Pattern Strainers: For water, install on supply side of each control valve, water pressure-reducing valve, solenoid valve and pump.

H. Outlet Boxes: Install boxes recessed in wall or surface mounted on wall. Install 2-by-4-inch (38-by-89-mm) fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."

I. Hose Stations: Install with check stops or shutoff valves on inlets and with thermometer on outlet.

1. Install cabinet-type units recessed in or surface mounted on wall as specified. Install 2-by-4-inch (38-by-89-mm) fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."

J. Ground Hydrants: Install with 1 (0.75) cu. yd. (cu. m) of crushed gravel around drain hole. Set ground hydrants with box flush with grade.

K. Nonfreeze, Draining-Type Post Hydrants: Install with 1 (0.75) cu. yd. (cu. m) of crushed gravel around drain hole. Set post hydrants in concrete paving or in 1 (0.03) cu. ft. (cu. m) of concrete block at grade.

L. Freeze-Resistant Sanitary Yard Hydrants: Set with riser pipe in concrete or pavement. Do not encase canister in concrete.

M. Water-Hammer Arresters: Install in water piping according to PDI-WH 201.

N. Supply-Type, Trap-Seal Primer Device: Install with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

O. Drainage-Type, Trap-Seal Primer Device: Install as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

P. Trap-Seal Primer Systems: Install with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.02 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

C. Comply with requirements for grounding equipment in Section 260526 "Grounding and Bonding for Electrical Systems."

3.03 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test each pressure vacuum breaker reduced-pressure-principle backflow preventer double-check, backflow-prevention assembly and double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device's reference standard.

B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.04 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION 221119

SECTION 22 11 23.21 - INLINE, DOMESTIC-WATER PUMPS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. In-line, sealless centrifugal pumps.
2. Horizontally mounted, in-line, separately coupled centrifugal pumps.
3. Horizontally mounted, in-line, close-coupled centrifugal pumps.
4. Vertically mounted, in-line, close-coupled centrifugal pumps.

B. Related Requirements:

1. Section 221123.13 "Domestic-Water Packaged Booster Pumps" for booster systems.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction materials, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For inline, domestic-water pumps to include in operation and maintenance manuals.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written instructions for handling.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: UL 778 for motor-operated water pumps.

C. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

D. Seismic Performance: Inline, domestic-water pumps shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.02 IN-LINE, SEALLESS CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bell & Gossett Domestic Pump; ITT Corporation.
2. Grundfos Pumps Corp.
3. TACO Incorporated.
4. WILO USA LLC - WILO Canada Inc.

C. Capacities and Characteristics: See schedule on plans.

D. Pump Construction:

1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
2. Minimum Working Pressure: 125 psig (860 kPa).
3. Maximum Continuous Operating Temperature: 220 deg F (104 deg C).
4. Casing: Bronze, with threaded or companion-flange connections.
5. Impeller: Plastic, composite, or stainless steel.
6. Motor: Single speed, unless otherwise indicated.

2.03 HORIZONTALLY MOUNTED, IN-LINE, SEPARATELY COUPLED CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, in-line, single-stage, separately coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shafts mounted horizontal.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bell & Gossett; a Xylem brand.
2. TACO Comfort Solutions, Inc.
3. Thrush Co. Inc.

A. Capacities and Characteristics: See schedule on plans.

B. Pump Construction:

1. Casing:

a. Radially split bronze, cast iron, or stainless steel with threaded companion-flange connections for pumps with NPS 2 (DN 50) pipe connections and flanged connections for pumps with NPS 2-1/2 (DN 65) pipe connections.
b. Built to permit servicing of pump internals without disturbing the casing or the suction and discharge piping.
c. Gauge port tappings at suction and discharge nozzles.

2. Impeller: Bronze or stainless steel, statically and dynamically balanced, closed, and keyed to shaft.
3. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
4. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
5. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket.
6. Bearings: permanently lubricated ball type.
7. Minimum Working Pressure: 125 psig (860 kPa).
8. Continuous Operating Temperature: 200 deg F (93 deg C).

C. Motor: Single speed, with permanently lubricated ball bearings; and resiliently or rigidly mounted to pump casing.

2.04 HORIZONTALLY MOUNTED, IN-LINE, CLOSE-COUPLED CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted horizontal.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bell & Gossett; a Xylem brand.
2. TACO Comfort Solutions, Inc.
3. Thrush Co. Inc.

C. Capacities and Characteristics: See schedule on plans.

D. Pump Construction:

1. Casing:

a. Radially split bronze, brass, or cast iron with threaded companion-flange connections for pumps with NPS 2 (DN 50) pipe connections and flanged connections for pumps with NPS 2-1/2 (DN 65) pipe connections.
b. Built to permit servicing of pump internals without disturbing the casing or the suction and discharge piping.
c. Gauge port tappings at suction and discharge nozzles.

2. Impeller: Bronze or brass, statically and dynamically balanced, closed, and keyed to shaft.
3. Shaft and Shaft Sleeve: Steel shaft with deflector, with copper-alloy shaft sleeve. Include water slinger on shaft between motor and seal.
4. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
5. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket.
6. Bearings: permanently lubricated ball type.
7. Minimum Working Pressure: 175 psig (1200 kPa).
8. Continuous Operating Temperature: 225 deg F (107 deg C).

E. Motor: Single speed, with grease-lubricated ball bearings; resiliently or rigidly mounted to pump casing.

2.05 VERTICALLY MOUNTED, IN-LINE, CLOSE-COUPLED CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted vertical.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bell & Gossett; a Xylem brand.
2. Grundfos Pumps Corp.
3. TACO Comfort Solutions, Inc.
4. Thrush Co. Inc.
5. WILO USA LLC - WILO Canada Inc.

C. Capacities and Characteristics: See schedule on plans.

D. Pump Construction:

1. Casing: Radially split bronze, cast or ductile iron, with wear rings and threaded companion-flange connections for pumps with NPS 2 (DN 50) pipe connections and flanged connections for pumps with NPS 2-1/2 (DN 65) pipe

connections. Include pump manufacturer's base attachment for mounting pump on concrete base.

2. Impeller: Bronze, brass, or stainless steel, statically and dynamically balanced, closed, and keyed to shaft.
3. Shaft and Shaft Sleeve: Steel or stainless-steel shaft, with copper-alloy shaft sleeve.
4. Shaft Coupling: Flexible or rigid type if pump is provided with coupling.
5. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket. Include water slinger on shaft between motor and seal.
6. Bearings: Oil-lubricated; bronze-journal or ball type.
7. Minimum Working Pressure: 175 psig (1200 kPa).
8. Continuous Operating Temperature: 225 deg F (107 deg C).

E. Motor: Single speed, with grease-lubricated ball bearings; rigidly mounted to pump casing.

2.06 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.07 CONTROLS

A. Aquastat: For control of hot-water circulation pump.
1. Type: Aquastat sensor, for installation in piping.
2. Operation of Pump: On or off.
3. Power Requirement: 120 V, ac.
4. Settings: Start pump at 95 deg F (35 deg C) and stop pump at 115 deg F (46 deg C).

B. Timers: For control of hot-water circulation pump.
1. Type: Programmable, seven-day clock.
2. Operation of Pump: On or off.
3. Power Requirement: 120-V ac with 4-day capacitor memory back-up.
4. Programmable Sequence of Operation: Up to ten on-off cycles.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for domestic-water-piping system to verify actual locations of piping connections before pump installation.

3.02 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Mount pumps in orientation complying with manufacturer's written instructions.

C. Pump Mounting:

1. Install vertically mounted, in-line, close-coupled centrifugal pumps with cast-iron base mounted on concrete base using vibration isolation type and deflection as specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment." Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Install continuous-thread hanger rods and vibration isolation of size required to support pump weight.

1. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment." Fabricate brackets or supports as required.
2. Comply with requirements for hangers and supports specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

E. Install aquastats in hot-water return piping adjacent to pump

F. Install timers on wall adjacent to pump.

3.03 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to inline, domestic-water pumps, allow space for service and maintenance.

C. Connect domestic-water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.

1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:

a. Horizontally mounted, in-line, separately coupled centrifugal pumps.
b. Horizontally mounted, in-line, close-coupled centrifugal pumps.
c. Vertically mounted, in-line, close-coupled centrifugal pumps.
d. Comply with requirements for flexible connectors specified in Section 221116 "Domestic Water Piping."

D. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for strainers specified in Section 221119 "Domestic Water Piping Specialties." Comply with requirements for valves specified in the following:

1. Section 220523.12 "Ball Valves for Plumbing Piping."
2. Section 220523.13 "Butterfly Valves for Plumbing Piping."
3. Section 220523.14 "Check Valves for Plumbing Piping."
4. Section 220523.15 "Gate Valves for Plumbing Piping."
5. Install pressure gauge and snubber at suction of each pump and pressure gauge and snubber at discharge of each pump. Install at integral pressure-gauge tappings where provided or install pressure-gauge connectors in suction and discharge piping around pumps. Comply with requirements for pressure gauges and snubbers specified in Section 220519 "Meters and Gages for Plumbing Piping."

3.04 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between temperature controllers and devices.

C. Interlock pump between water heater and hot-water storage tank with water heater burner and time-delay relay.

3.05 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment" for identification of pumps.

3.06 FIELD QUALITY CONTROL

A. Perform Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Inline, domestic-water pump will be considered defective if it does not pass tests and inspections.

3.07 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Perform the following startup checks for each pump before starting:

    a. Verify bearing lubrication.
    b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    c. Verify that pump is rotating in the correct direction.

5. Prime pump by opening suction valves and closing drains and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.
8. Adjust timer settings.

3.08 ADJUSTING

A. Adjust inline, domestic-water pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION 221123.21

SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless, cast-iron soil pipe and fittings.
3. Galvanized-steel pipe and fittings.
4. Copper tube and fittings.
5. PVC pipe and fittings.
6. Specialty pipe fittings.
7. Encasement for underground metal piping.

B. Related Requirements:

1. Section 221313 "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.
2. Section 221329 "Sanitary Sewerage Pumps" for effluent and sewage pumps.
3. Section 226600 "Chemical-Waste Systems for Laboratory and Healthcare Facilities" for chemical-waste and vent piping systems.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.04 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.05 FIELD CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water (30 kPa).
2. Waste, Force-Main Piping: 50 psig (345 kPa).

2.02 PIPING MATERIALS

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.03 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74 bearing collective trademark of CISPI, Service and Extra Heavy classes.

B. Gaskets: ASTM C 564, rubber.

2.04 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301 bearing collective trademark of CISPI.

B. Heavy-Duty, Hubless-Piping Couplings:

1. Standards: ASTM C 1277 and ASTM C 1540.
2. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.05 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Standard Weight class. Include threaded ends matching joining method.

B. Galvanized-Cast-Iron Drainage Fittings: ASME B16.12, threaded.

C. Steel Pipe Pressure Fittings:

1. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Schedule 40, seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
3. Galvanized-Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.

2.06 COPPER TUBE AND FITTINGS

A. Copper Type DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

C. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M), water tube, drawn temper.

D. Copper Pressure Fittings:

1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

E. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.07 PVC PIPE AND FITTINGS

A. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

B. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

D. Adhesive Primer: ASTM F 656.

E. Solvent Cement: ASTM D 2564.

2.08 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2. Shielded, Nonpressure Transition Couplings:

   a. Standard: ASTM C 1460.
   b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
   c. End Connections: Same size as and compatible with pipes to be joined.

3. Pressure Transition Couplings:

   a. Standard: AWWA C219.
   b. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
   c. Center-Sleeve Material: Manufacturer's standard.
   d. Gasket Material: Natural or synthetic rubber.
   e. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

1. Dielectric Unions:

   a. Description:

      1) Standard: ASSE 1079.
      2) Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
      3) End Connections: Solder-joint copper alloy and threaded ferrous.

2. Dielectric Flanges:

   a. Description:

      1) Standard: ASSE 1079.
      2) Factory-fabricated, bolted, companion-flange assembly.
      3) Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
      4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

3. Dielectric-Flange Insulating Kits:

   a. Description:

      1) Nonconducting materials for field assembly of companion flanges.
      2) Pressure Rating: 150 psig (1035 kPa).
      3) Gasket: Neoprene or phenolic.
      4) Bolt Sleeves: Phenolic or polyethylene.
      5) Washers: Phenolic with steel backing washers.

4. Dielectric Nipples:

    a. Description:

        1) Standard: IAPMO PS 66.
        2) Electroplated steel nipple.
        3) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
        4) End Connections: Male threaded.
        5) Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.01 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.02 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
2. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.

1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.

    a. Straight tees, elbows, and crosses may be used on vent lines.

3. Do not change direction of flow more than 90 degrees.
4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

    a. Reducing size of waste piping in direction of flow is prohibited.

K. Lay buried building waste piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Maintain swab in piping and pull past each joint as completed.

L. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 1 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
2. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

N. Install steel piping according to applicable plumbing code.

O. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

P. Install aboveground PVC piping according to ASTM D 2665.

Q. Install underground PVC piping according to ASTM D 2321.

R. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."

S. Install force mains at elevations indicated.

T. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.

    a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
    b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."

2. Install drains in sanitary waste gravity-flow piping.

    a. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

U. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

V. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

W. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

X. Install escutcheons for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.03 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.

1. Cut threads full and clean using sharp dies.
2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

    a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
    b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
    c. Do not use pipe sections that have cracked or open welds.

D. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

E. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 appendixes.

3.04 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Waste Drainage Piping: Shielded, non-pressure transition couplings.
3. In Aboveground Force Main Piping: Fitting-type transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric nipples.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flange kits or nipples.
4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.05 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:

    a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

8. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting, valve, and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.
4. NPS 6 and NPS 8 (DN 150 and DN 200): 60 inches (1500 mm) with 3/4-inch (19-mm) rod.
5. NPS 10 and NPS 12 (DN 250 and DN 300): 60 inches (1500 mm) with 7/8-inch (22-mm) rod.
6. Spacing for 10-foot (3-m) lengths may be increased to 10 feet (3 m). Spacing for fittings is limited to 60 inches (1500 mm).

F. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).

G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 (DN 32): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
5. NPS 3 (DN 80): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
7. NPS 6 and NPS 8 (DN 150 and DN 200): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
8. NPS 10 and NPS 12 (DN 250 and DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.

H. Install supports for vertical steel piping every 15 feet (4.5 m).

I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 (DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
2. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
3. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.

4. NPS 3 and NPS 5 (DN 80 and DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
5. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
6. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.

J. Install supports for vertical copper tubing every 10 feet (3 m).

K. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
2. NPS 3 (DN 80): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
3. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
4. NPS 6 and NPS 8 (DN 150 and DN 200): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
5. NPS 10 and NPS 12 (DN 250 and DN 300): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.

L. Install supports for vertical PVC piping every 48 inches (1200 mm).

M. Support piping and tubing not listed above according to MSS SP-58 and manufacturer's written instructions.

3.06 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Install horizontal backwater valves with cleanout cover flush with floor.
6. Comply with requirements for backwater valves cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."
7. Equipment: Connect waste piping as indicated.

    a. Provide shutoff valve if indicated and union for each connection.
    b. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.

D. Connect force-main piping to the following:

1. Sanitary Sewer: To exterior force main.
2. Sewage Pump: To sewage pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.07 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.

B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.08 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

    a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.

a. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.

a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa).
b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
c. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.

a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg (250 Pa).
b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
c. Air pressure must remain constant without introducing additional air throughout period of inspection.
d. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.

a. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials.

a. Isolate test source and allow to stand for four hours.
b. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.09 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.010 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil, waste, and vent piping shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
3. Copper Type DWV tube, copper drainage fittings, and soldered joints.
4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

C. Underground, soil, waste, and vent piping shall be any of the following:

1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
3. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

D. Aboveground kitchen waste piping exposed to 140-deg or higher temperatures shall be the following:
1. Copper DWV tube, copper drainage fittings, and soldered joints.

E. Underground kitchen waste piping exposed to 140-deg or higher temperatures shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
3. Copper DWV tube, copper drainage fittings, and soldered joints.

F. Underground waste piping exposed to 140-deg or higher temperatures shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.

G. Aboveground sanitary-sewage force mains shall be any of the following:

1. Hard copper tube, Type L (Type B); copper pressure fittings; and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.

END OF SECTION 221316

SECTION 22 13 19 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Backwater valves.
2. Cleanouts.
3. Air-admittance valves.
4. Roof flashing assemblies.
5. Through-penetration firestop assemblies.
6. Trap seal protection devices.
7. Miscellaneous sanitary drainage piping specialties.
8. FOG disposal systems.

B. Related Requirements:

1. Section 221423 "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.
2. Section 224300 "Healthcare Plumbing Fixtures" for plaster sink interceptors.
3. Section 334200 "Stormwater Conveyance" for storm drainage piping and piping specialties outside the building.

1.03 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene.

B. FOG: Fats, oils, and greases.

C. PVC: Polyvinyl chloride.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rated capacities, operating characteristics, and accessories for the following:

1. FOG disposal systems.

B. Shop Drawings:

1. Show fabrication and installation details for frost-resistant vent terminals.

1.05 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: For FOG disposal systems, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.01 ASSEMBLY DESCRIPTIONS

A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary waste piping specialty components.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing, and marked for intended location and application.

2.02 BACKWATER VALVES

A. Horizontal, Cast-Iron Backwater Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Jay R. Smith Mfg. Co.
b. Josam Company.
c. MIFAB, Inc.
d. Tyler Pipe; a subsidiary of McWane Inc.

e. WATTS.
f. Zurn Industries, LLC.

2. Standard: ASME A112.14.1.

3. Size: Same as connected piping.
4. Body: Cast iron.
5. Cover: Cast iron with bolted or threaded access check valve.
6. End Connections: Hub and spigot or hubless.
7. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang open for airflow unless subject to backflow condition.
8. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Drain-Outlet Backwater Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Jay R. Smith Mfg. Co.
b. Josam Company.
c. WATTS.
d. Zurn Industries, LLC.

2. Size: Same as floor drain outlet.
3. Body: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
4. Check Valve: Removable ball float.
5. Inlet: Threaded.
6. Outlet: Threaded or spigot.

C. Horizontal, Plastic Backwater Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. IPS Corporation.
b. Oatey.
c. Sioux Chief Manufacturing Company, Inc.
d. Zurn Industries, LLC.

2. Size: Same as connected piping.

3. Body: ABS.
4. Cover: Same material as body with threaded access to check valve.
5. Check Valve: Removable swing check.
6. End Connections: Socket type.

2.03 CLEANOUTS

A. Cast-Iron Exposed Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Jay R. Smith Mfg. Co.
    b. Josam Company.
    c. MIFAB, Inc.
    d. Tyler Pipe; a subsidiary of McWane Inc.
    e. WATTS.
    f. Zurn Industries, LLC.

2. Standard: ASME A112.36.2M.
3. Size: Same as connected drainage piping
4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
5. Closure: Countersunk or raised-head, plastic plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. See Plumbing Fixture Schedule on plans for more details.

B. Stainless-Steel Exposed Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. BLÜCHER; A Watts brand.
    b. Josam Company.
    c. WATTS.

2. Standard: ASME A112.3.1.

3. Size: Same as connected drainage piping
4. Body Material: Stainless-steel tee with side cleanout as required to match connected piping.
5. Closure: Stainless-steel plug with seal.
6. See Plumbing Fixture Schedule on plans for more details.

C. Cast-Iron Exposed Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Jay R. Smith Mfg. Co.
    b. Josam Company.
    c. Oatey.
    d. Sioux Chief Manufacturing Company, Inc.
    e. Tyler Pipe; a subsidiary of McWane Inc.
    f. WATTS.
    g. Zurn Industries, LLC.

2. Standard: ASME A112.36.2M for heavy-duty, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Body or Ferrule: Cast iron.
5. Closure: Plastic plug.
6. Adjustable Housing Material: Cast iron with threads.
7. Riser: ASTM A 74, Extra-Heavy class, cast-iron drainage pipe fitting and riser to cleanout.
8. See Plumbing Fixture Schedule on plans for more details.

D. Stainless-Steel Exposed Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. BLÜCHER; A Watts brand.
   b. Josam Company.
   c. Kusel Equipment Co.
   d. WATTS.
   e. Zurn Industries, LLC.

E. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Jay R. Smith Mfg. Co.
   b. Josam Company.
   c. MIFAB, Inc.
   d. Tyler Pipe; a subsidiary of McWane Inc.
   e. WATTS.
   f. Zurn Industries, LLC.

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure Plug:
   a. Countersunk or raised head.
   b. Drilled and threaded for cover attachment screw.
   c. Size: Same as or not more than one size smaller than cleanout size.

6. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

F. Plastic Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. IPS Corporation.
   b. Sioux Chief Manufacturing Company, Inc.
   c. Zurn Industries, LLC.

2. Size: Same as connected branch.
3. Body: PVC.
4. Closure Plug: PVC.
5. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

2.04 AIR-ADMITTANCE VALVES

A. Fixture Air-Admittance Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Ayrlett, LLC.
   b. Durgo, Inc.
   c. Oatey.
   d. ProSet Systems Inc.
   e. RectorSeal.
   f. Studor, Inc.

2. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.
3. Housing: Plastic.
4. Operation: Mechanical sealing diaphragm.
5. Size: Same as connected fixture or branch vent piping.

B. Stack Air-Admittance Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Durgo, Inc.
   b. Oatey.
   c. Studor, Inc.

2. Standard: ASSE 1050 for vent stacks.
3. Housing: Plastic.
4. Operation: Mechanical sealing diaphragm.
5. Size: Same as connected stack vent or vent stack.

C. Wall Box for Air-Admittance Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Durgo, Inc.
   b. Oatey.
   c. RectorSeal.
   d. Studor, Inc.
   e. Zurn Industries, LLC.

2. Description: White plastic housing with white plastic grille, made for recessed installation. Include bottom pipe connection and space to contain one air-admittance valve.
3. Size: About 9 inches wide by 8 inches high by 4 inches deep (230 mm wide by 200 mm high by 100 mm deep).

2.05 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Acorn Engineering Company.
   b. Thaler Metal Industries Ltd.
   c. Zurn Industries, LLC.

2. Description: Manufactured assembly made of 4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch- (1.6-mm-) thick, lead flashing collar and skirt extending at least 6 inches (150 mm) from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

   a. Open-Top Vent Cap: Without cap.

2.06 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. ProSet Systems Inc.

2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
3. Size: Same as connected soil, waste, or vent stack.
4. Sleeve: Molded-PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
6. Special Coating: Corrosion resistant on interior of fittings.

2.07 TRAP SEAL PROTECTION DEVICES

A. Barrier Type Trap Seal Protection Devices:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. SureSeal Manufacturing; Inline Floor Drain Trap Sealer.

2. Standard: ASSE 1072-2007.
3. Body: ASB Plastic
4. Diaphragm & Sealing Gasket: Neoprene Rubber
5. Size: Match Drain Pipe Size.
6. Gravity Drain Outlet Connection: Compression fit sealing gasket 80 durometer.

2.08 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564 rubber gaskets.
2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.

a. NPS 2 (DN 50): 4-inch- (100-mm-) minimum water seal.
b. NPS 2-1/2 (DN 65) and Larger: 5-inch- (125-mm-) minimum water seal.

C. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 (DN 15) side inlet.

D. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

E. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch (25 mm) above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

F. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

G. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

H. Frost-Resistant Vent Terminals:

1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
2. Design: To provide 1-inch (25-mm) enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

I. Expansion Joints:

1. Standard: ASME A112.6.4.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

2.09 FOG DISPOSAL SYSTEMS

A. FOG Disposal Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Jay R. Smith Mfg. Co.

2. Standard: ASME A112.14.6, for removing solids from and breaking down and digesting suspended fats, oils, and greases from food-preparation or -processing wastewater.
3. Flow-Control Fitting: Matching unit size.
4. Strainer Unit: Stainless-steel housing with aluminum cover and removable-basket-type, stainless-steel, wire-mesh strainer. Include pressure plug instead of cover.
5. Media Chamber: Stainless-steel housing and aluminum cover, with internal baffles, piping, plastic coalescing surfaces, and clarifier section with test ports. Include stainless-steel extension.
6. Shelf: Stainless steel, 19-1/2 inches wide by 13 inches high by 8-3/4 inches deep (495 mm wide by 330 mm high by 222 mm deep), for metering pump, control devices, and culture bottle.
7. Culture Metering Pump, Timer, Control, and Tubing: Proprietary.
8. Culture: Include 1-gal. (3.8-L) bottle, as recommended by unit manufacturer.
9. Strainer and Media Chamber, Unit Size: 20 gpm (1.26 L/s).

10. Inlet and Outlet: NPS 2 (DN 50).
11. Strainer and Media-Chamber, Unit Size: 50 gpm (3.15 L/s).
12. Inlet and Outlet: NPS 3 (DN 80).
13. Piping: Waste and vent piping is specified in Section 221316 "Sanitary Waste and Vent Piping."
14. Power Requirement: 120-V ac.

2.010 MOTORS

A. General requirements for motors are specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, motor shall be large enough, so driven load will not require motor to operate in service factor range above 1.0.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Equipment Mounting:

1. Install FOG disposal systems on cast-in-place concrete equipment base(s).

a. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

2. Comply with requirements for vibration-isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."

B. Install backwater valves in building drain piping.

1. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

C. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
4. Locate at base of each vertical soil and waste stack.

D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

F. Install fixture air-admittance valves on fixture drain piping.

G. Install stack air-admittance valves at top of stack vent and vent stack piping.

H. Install air-admittance-valve wall boxes recessed in wall.

I. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."

J. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."

K. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.

1. Comply with requirements in Section 078413 "Penetration Firestopping."

L. Assemble open drain fittings and install with top of hub 2 inches (51 mm) above floor.

M. Install deep-seal traps on floor drains and other waste outlets, if indicated.

N. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

O. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

P. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.

Q. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch (25-mm) clearance between vent pipe and roof substrate.

R. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

S. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch (25-mm) clearance between vent pipe and roof substrate.

T. Assemble components of FOG disposal systems and install on floor.

1. Install trap, vent, fresh-air inlet, and flow-control fitting according to authorities having jurisdiction.

2. Install shelf fastened to reinforcement in wall construction and adjacent to unit, unless otherwise indicated.
3. Install culture bottle, culture metering pump, timer, and control on shelf. Install tubing between culture bottle, metering pump, and chamber.

U. Install wood-blocking reinforcement for wall-mounting-type specialties.

V. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.02 CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. FOG Disposal Systems: Connect inlet and outlet to unit, connect flow-control fitting and fresh-air inlet piping to unit inlet piping, and connect vent piping between trap and media chamber. Connect electrical power.

D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.03 FLASHING INSTALLATION

A. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."

B. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required.

C. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches (250 mm), and skirt or flange extending at least 8 inches (200 mm) around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around specialty.

D. Set flashing on floors and roofs in solid coating of bituminous cement.

E. Secure flashing into sleeve and specialty clamping ring or device.

F. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 076200 "Sheet Metal Flashing and Trim."

G. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

3.04 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. FOG disposal systems.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.

1. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.05 FIELD QUALITY CONTROL

A. Perform tests and inspections, and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled FOG disposal systems and their installation, including piping and electrical connections, and to assist in testing.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.06 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.07 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain FOG disposal systems. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 221319

SECTION 22 13 19.13 - SANITARY DRAINS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Floor drains.
2. Trench drains.
3. Channel drainage systems.

1.03 DEFINITIONS

A. ABS: Acrylonitrile-butadiene styrene.

B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene.

D. PE: Polyethylene.

E. PP: Polypropylene.

F. PVC: Polyvinyl chloride.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 DRAIN ASSEMBLIES

A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.02 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Jay R. Smith Mfg. Co.
   b. Josam Company.
   c. MIFAB, Inc.
   d. Wade; a subsidiary of McWane Inc.
   e. WATTS.
   f. Zurn Industries, LLC.

2. Standard: ASME A112.6.3 with backwater valve.
3. See Plumbing Fixture Schedule on plans for more details.

B. Stainless-Steel Floor Drains, ASME A112.3.1:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Zurn Industries, LLC.

C. Stainless-Steel Floor Drains, ASME A112.6.3:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Jay R. Smith Mfg. Co.
   b. Josam Company.
   c. Kusel Equipment Co.
   d. Scherping Systems, Inc.
   e. WATTS.
   f. Zurn Industries, LLC.

2. Standard: ASME A112.3.1] [ASME A112.6.3.
3. See Plumbing Fixture Schedule on plans for more details.

D. Plastic Floor Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. IPS Corporation.
   b. Josam Company.
   c. Oatey.
   d. Plastic Oddities.
   e. Sioux Chief Manufacturing Company, Inc.
   f. Zurn Industries, LLC.

2. Standard: ASME A112.6.3.
3. See Plumbing Fixture Schedule on plans for more details.

2.03 TRENCH DRAINS

A. Trench Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Jay R. Smith Mfg. Co.
    b. Josam Company.
    c. MIFAB, Inc.
    d. Wade; a subsidiary of McWane Inc.
    e. WATTS.
    f. Zurn Industries, LLC.

2. Standard: ASME A112.6.3 for trench drains.
3. See Plumbing Fixture Schedule on plans for more details.

2.04 CHANNEL DRAINAGE SYSTEMS

A. Stainless-Steel Channel Drainage Systems, ASME A112.3.1:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Josam Company.

2. Description: Modular system of stainless-steel channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
3. Standard: ASME A112.3.1 for trench drains.
4. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
5. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
6. See Plumbing Fixture Schedule on plans for more details.

B. Narrow, Sloped-Invert, Polymer-Concrete Channel Drainage Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ABT, Inc.
    b. ACO USA.
    c. Jay R. Smith Mfg. Co.
    d. Josam Company.

2. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
3. Channel Sections: Narrow, interlocking-joint, sloped-invert, polymer-concrete modular units with end caps.

    a. Include rounded bottom, with built-in invert slope of 0.6 percent and with outlets in number, sizes, and locations indicated.
    b. Include extension sections necessary for required depth.
    c. Dimensions: 4-inch (102-mm) inside width. Include number of units required to form total lengths indicated.
    d. Frame: Gray-iron or galvanized steel for grates.

4. Grates: Manufacturer's designation "heavy duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.

    a. Material: Ductile iron.

        1) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.

5. Covers: Solid ductile or gray iron, of width and thickness that fit recesses in channel sections, and of lengths indicated.
6. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
7. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

C. Narrow, Level-Invert, Polymer-Concrete Channel Drainage Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ABT, Inc.
    b. ACO USA.
    c. Josam Company.

2. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
3. Channel Sections: Narrow, interlocking-joint, precast, polymer-concrete modular units with end caps.

    a. Include rounded bottom, with level invert and with NPS 4 (DN 100) outlets in number and locations indicated.
    b. Dimensions: 5-inch (127-mm) inside width and 9-3/4 inches (248 mm) deep. Include number of units required to form total lengths indicated.

        1) Frame: Gray-iron or galvanized steel for grates.

4. Grates: Manufacturer's designation "heavy duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.

a. Material: Ductile iron.
b. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.

5. Covers: Solid ductile or gray iron, of width and thickness that fit recesses in channel sections, and of lengths indicated.
6. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
7. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

D. Wide, Level-Invert, Polymer-Concrete Channel Drainage Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABT, Inc.
b. ACO USA.
c. Josam Company.

2. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.

3. Channel Sections: Wide, interlocking-joint, precast, polymer-concrete modular units with end caps.

a. Include flat or rounded bottom, with level invert and with outlets in number, sizes, and locations indicated.
b. Dimensions: 8-inch (203-mm) inside width and 13-3/4 inches (350 mm) deep. Include number of units required to form total lengths indicated.

1) Frame: Gray-iron or galvanized steel for grates.

4. Grates: Manufacturer's designation "heavy duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.

a. Material: Ductile iron.
b. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.

5. Covers: Solid ductile or gray iron, of width and thickness that fit recesses in channel sections, and of lengths indicated.
6. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
7. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

E. FRP Channel Drainage Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ACO USA.
b. Jay R. Smith Mfg. Co.
c. Zurn Industries, LLC.

2. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.

3. Channel Sections: Interlocking-joint, sloped-invert, FRP modular units, with end caps. Include flat, rounded, or inclined inside bottom, with outlets in number, sizes, and locations indicated.

   a. Dimensions: 4 inches (102 mm) wide. Include number of units required to form total lengths indicated.
   b. Frame: Galvanized steel for grates.

4. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.

   a. Material: Fiberglass.
   b. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.

5. Covers: Solid ductile or gray iron, of width and thickness that fit recesses in channel sections, and of lengths indicated.
6. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
7. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

F. HDPE or PE Channel Drainage Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Jay R. Smith Mfg. Co.
   b. Zurn Industries, LLC.

2. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.

3. Channel Sections: Interlocking-joint, HDPE or PE modular units, with end caps. Include flat, rounded, or inclined bottom, with level invert and with outlets in number, sizes, and locations indicated.

   a. Dimensions: 4 inches (102 mm) wide. Include number of units required to form total lengths indicated.

4. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.

   a. Material: Fiberglass.

5. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
6. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

G. PP Channel Drainage Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Jay R. Smith Mfg. Co.

2. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.

3. Channel Sections: Interlocking-joint, PP modular units, with end caps. Include flat, rounded, or inclined bottom, with level invert and with outlets in number, sizes, and locations indicated.

   a. Dimensions: 4 inches (102 mm) wide. Include number of units required to form total lengths indicated.

4. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.

   a. Material: Fiberglass.

5. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
6. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

H. PVC Channel Drainage Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. MultiDrain Systems, Inc.
   b. NDS Inc.

2. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.

3. Channel Sections: Interlocking-joint, PVC modular units, with end caps. Include flat, rounded, or inclined bottom, with level invert and with outlets in number, sizes, and locations indicated.

   a. Dimensions: 4 inches (102 mm) wide. Include number of units required to form total lengths indicated.

4. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.

    a. Material: Fiberglass.

5. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
6. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
3. Set with grates depressed according to the following drainage area radii:

    a. Radius, 30 Inches (750 mm) or Less: Equivalent to 1 percent slope, but not less than 1/4-inch (6.35-mm) total depression.
    b. Radius, 30 to 60 Inches (750 to 1500 mm): Equivalent to 1 percent slope.
    c. Radius, 60 Inches (1500 mm) or Larger: Equivalent to 1 percent slope, but not greater than 1-inch (25-mm) total depression.

4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.

    a. Maintain integrity of waterproof membranes where penetrated.

5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

B. Install trench drains at low points of surface areas to be drained.

1. Set grates of drains flush with finished surface, unless otherwise indicated.

C. Comply with ASME A112.3.1 for installation of stainless-steel channel drainage systems.

1. Install on support devices, so that top will be flush with adjacent surface.

D. Install FRP channel drainage system components on support devices, so that top will be flush with adjacent surface.

E. Install plastic channel drainage system components on support devices, so that top will be flush with adjacent surface.

F. Install open drain fittings with top of hub 1 inch (25 mm) above floor.

3.02 CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements in Section 221319 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.

C. Comply with requirements in Section 221323 "Sanitary Waste Interceptors" for grease interceptors, grease-removal devices, oil interceptors, sand interceptors, and solid interceptors.

D. Install piping adjacent to equipment to allow service and maintenance.

E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.03 LABELING AND IDENTIFYING

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.04 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319.13

SECTION 221323 - SANITARY WASTE INTERCEPTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following types of interceptors outside the building:
   1. Oil interceptors.
   2. Sand interceptors.
   3. Sediment interceptors.

1.3 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

B. HDPE: High-density polyethylene plastic.

C. PE: Polyethylene plastic.

D. PP: Polypropylene plastic.

1.4 SUBMITTALS

A. Product Data: For each type of metal and plastic interceptor indicated. Include materials of fabrication, dimensions, rated capacities, retention capacities, operating characteristics, size and location of each pipe connection, furnished specialties, and accessories.

B. Shop Drawings: For each type and size of cast-in-place-concrete interceptor indicated.

   1. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.
   2. Include reports and calculations for design mixes of concrete.

C. Shop Drawings: For each type and size of precast concrete interceptor indicated.

   1. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.

D. Coordination Drawings: Interceptors, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Interceptors.
2. Piping connections. Include size, location, and elevation of each.
3. Interface with underground structures and utility services.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Sewer Services: Do not interrupt services to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sewer services according to requirements indicated:

1. Notify Architect no fewer than [seven] days in advance of proposed interruption of service.
2. Do not proceed with interruption of sewer services without Architect's permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 OIL INTERCEPTORS

A. Oil Interceptors: Cast-in-place-concrete or precast concrete structure complying with requirements of <Insert authority title>.

B. Oil Interceptors: Construct bottom, sidewalls, and top of reinforced, cast- in-place concrete. Include waste oil and vent connections, manholes, compartments or baffles, and piping or openings to draw off oil and to permit wastewater flow.

1. Concrete: Comply with ACI 318/318R, ACI 350R.

a. Design Mix: 4000 psig (27.6 MPa) minimum, with 0.45 maximum water-to-cementitious materials ratio.
b. Portland Cement: ASTM C 150, Type II.
c. Fine Aggregate: ASTM C 33, sand.
d. Coarse Aggregate: ASTM C 33, crushed gravel.
e. Water: Potable.

f. Reinforcing Fabric: ASTM A 185, steel, welded wire fabric, plain.
g. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa), deformed steel.

C. Oil/Sediment/Sand Interceptors: Factory-fabricated, cast-iron or steel body; with removable sediment bucket or strainer, baffles, vents, and flow-control fitting on inlet.

1. Manufacturers:

a. Enpoco Div.; Watts Industries, Inc.
b. Josam Company.
c. MIFAB Manufacturing Inc.
d. Schier Products Company.
e. Smith, Jay R. Mfg. Co.
f. Wade Div.; Tyler Pipe.
g. Watts Industries, Inc.
h. Zurn Specification Drainage Products; Zurn Plumbing Products Group.

2. Inlet, Outlet, Vent, and Waste-Oil Outlet Piping Connections: Hub, hubless, or threaded, unless otherwise indicated.
3. Extension: Cast-iron or steel shroud, full size of interceptor, extending from top of interceptor to grade.
4. Cover: Cast iron or steel, with steel reinforcement to provide ASTM C 890, [Class D vehicle loads] load.
5. Protective Coating: Factory-applied, epoxy-polyamide paint; 10-15-mil (0.38-mm) minimum thickness applied to all ferrous surfaces, except bucket or strainer, unless otherwise indicated.
6. Waste-oil storage tank and piping are specified in Division 23 Section "Facility Fuel-Oil Piping."

D. Oil Interceptor Capacity and Characteristics:

1. Capacity: 50 GPM
2. Overall Dimensions: see schedule
3. Inlet and Outlet Pipe Size: 4”

a. Centerline of Inlet to Floor: see inverts
b. Centerline of Outlet to Floor: see inverts

4. Waste-Oil-Outlet Pipe Size: 2”

a. Centerline of Outlet to Floor: capped

5. Trapped Outlet Required: Integral, Yes.
6. Vent Pipe Size: 2”
7. Installation Position: Top flush with grade
8. Waste-Oil Storage Tank: [Not required]

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 1-14 Section "Earth Moving."

3.2 INSTALLATION

A. Install interceptor inlets and outlets at elevations indicated.

B. Install manhole risers from top of underground concrete interceptors to manholes and gratings at finished grade.

C. Set tops of manhole frames and covers flush with finished surface in pavements. Set tops [3 inches (75 mm)] <Insert other> above finish surface elsewhere, unless otherwise indicated.

D. Set tops of grating frames and grates flush with finished surface.

E. Clean and prepare metal surfaces to be field painted according to SSPC- PA 1. Paint the following metal surfaces according to SSPC-PA 1 and SSPC-Paint 16:

1. Metal Interceptors: All surfaces except baskets, screens, and strainers.
2. Plastic Interceptors: All metal surfaces except baskets, screens, and strainers.
3. Metal Manhole Frames and Covers[(Including Grates)]: All surfaces.
4. Do not paint metal surfaces with factory-applied, corrosion-resistant coating.

F. Set metal and plastic interceptors level and plumb.

G. Set tops of metal interceptor covers flush with finished surface in pavements.

H. Prepare and paint metal components, to be field painted, according to SSPC-Paint 16.

I. Install piping and oil storage tanks according to Division 23 Section "Facility Fuel-Oil Piping."

J. Repair and restore protective coatings to original condition.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Make piping connections between interceptors and piping systems.

3.4 IDENTIFICATION

A. Identification materials and installation are specified in Division 22 Section "Earth Moving." Arrange for installation of green warning tapes directly over piping and at outside edges of underground interceptors.

1. Use warning tapes or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

END OF SECTION 221323

SECTION 22 14 13 - FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless, cast-iron soil pipe and fittings.
3. Galvanized-steel pipe and fittings.
4. Ductile-iron pipe and fittings.
5. Copper tube and fittings.
6. ABS pipe and fittings.
7. PVC pipe and fittings.
8. Specialty pipe and fittings.
9. Encasement for underground metal piping.

B. Related Requirements:

1. Section 221429 "Sump Pumps" for storm drainage pumps.
2. Section 334400 "Stormwater Utility Equipment" for storm drainage piping outside the building.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For controlled-flow roof drainage system. Include calculations, plans, and details.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Detail storm drainage piping. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members to which drainage piping will be attached or suspended from.

B. Field quality-control reports.

1.05 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Storm Drainage Piping: **10-foot head of water (30 kPa)**.
2. Storm Drainage, Force-Main Piping: **50 psig (345 kPa)**.

2.02 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings:

1. Marked with CISPI collective trademark and NSF certification mark.
2. Class: ASTM A 74, Service and Extra Heavy class(es).

B. Gaskets: ASTM C 564, rubber.

C. Caulking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.03 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings:

1. Marked with CISPI collective trademark and NSF certification mark.
2. Standard: ASTM A 888 or CISPI 301.

B. CISPI, Hubless-Piping Couplings:
1. Couplings shall bear CISPI collective trademark and NSF certification mark.
2. Standards: ASTM C 1277 and CISPI 310.
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Hubless-Piping Couplings:
1. Standard: ASTM C 1540.
2. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

D. Cast-Iron, Hubless-Piping Couplings:
   1. Standard: ASTM C 1277.
   2. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.04 GALVANIZED-STEEL PIPE AND FITTINGS

A. Pipe: ASTM A 53/A 53M, Type E, Standard Weight class. Include square-cut-grooved or threaded ends matching joining method.

B. Cast-Iron Drainage Fittings: ASME B16.12, threaded.

C. Steel-Pipe Pressure Fittings:

   1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Schedule 40, seamless steel pipe. Include ends matching joining method.
   2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
   3. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.

D. Cast-Iron Flanges: ASME B16.1, Class 125.

   1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
   2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

E. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances
   1. Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A 536 ductile-iron castings, ASTM A 47/A 47M malleable-iron castings, ASTM A 234/A 234M forged-steel fittings, or ASTM A 106/A 106M steel pipes with dimensions matching ASTM A 53/A 53M steel pipe, and complying with AWWA C606 for grooved ends.
   2. Grooved Mechanical Couplings for Galvanized-Steel Piping: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber gasket suitable for hot and cold water; and bolts and nuts.

2.05 DUCTILE-IRON PIPE AND FITTINGS

A. Ductile-Iron, Mechanical-Joint Piping:

   1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
   3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Ductile-Iron, Push-on-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, push-on-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Gaskets: AWWA C111/A21.11, rubber.

C. Ductile-Iron, Grooved-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with round-cut-grooved ends according to AWWA C606.
2. Ductile-Iron, Grooved-End Pipe Appurtenances:
   a. Grooved-End, Ductile-Iron Fittings: ASTM A 536, ductile-iron castings with dimensions matching AWWA C110/A21.10, ductile-iron pipe or AWWA C153/A21.53, ductile-iron fittings; complying with AWWA C606 for grooved ends.
   b. Grooved Mechanical Couplings for Ductile-Iron Pipe: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber center-leg gasket suitable for hot and cold water; and bolts and nuts.

2.06 COPPER TUBE AND FITTINGS

A. Copper Type DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast-copper fittings or ASME B16.29, wrought-copper, solder-joint fittings.

C. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B), water tube, drawn temper.

D. Soft Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B), water tube, annealed temper.

E. Copper Pressure Fittings:

1. Copper Fittings: ASME B16.18, cast-copper-alloy fittings or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

F. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

G. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.07 ABS PIPE AND FITTINGS

A. NSF Marking: Comply with NSF 14, "Plastics Piping System Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.

B. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40.

C. Cellular-Core ABS Pipe: ASTM F 628, Schedule 40.

D. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.

E. Solvent Cement: ASTM D 2235.

2.08 PVC PIPE AND FITTINGS

A. NSF Marking: Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.

B. Solid-Wall PVC Pipe: ASTM D 2665; drain, waste, and vent.

C. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.

D. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

E. Adhesive Primer: ASTM F 656.

F. Solvent Cement: ASTM D 2564.

2.09 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
3. Unshielded, Nonpressure Transition Couplings:
    a. Standard: ASTM C 1173.
    b. Description: Elastomeric sleeve, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
    c. Sleeve Materials:

        1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.

2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Shielded, Nonpressure Transition Couplings:
   a. Standard: ASTM C 1460.
   b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
   c. End Connections: Same size as and compatible with pipes to be joined.

5. Pressure Transition Couplings:
   a. Standard: AWWA C219.
   b. Description: Metal, sleeve-type couplings same size as pipes to be joined, and with pressure rating at least equal to and ends compatible with pipes to be joined.
   c. Center-Sleeve Material: Manufacturer's standard.
   d. Gasket Material: Natural or synthetic rubber.
   e. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:
   a. Description:

      1) Standard: ASSE 1079.
      2) Pressure Rating: **150 psig (1035 kPa)** minimum at **180 deg F (82 deg C)**.
      3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:
   a. Description:

      1) Standard: ASSE 1079.
      2) Factory-fabricated, bolted, companion-flange assembly.
      3) Pressure Rating: **150 psig (1035 kPa)** minimum at **180 deg F (82 deg C)**.
      4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:
   a. Description:

      1) Nonconducting materials for field assembly of companion flanges.
      2) Pressure Rating: **150 psig (1035 kPa)**.
      3) Gasket: Neoprene or phenolic.

4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel-backing washers.

5. Dielectric Nipples:
   a. Description: Electroplated steel nipple.
   b. Standard: IAPMO PS 66.
   c. Pressure Rating: **300 psig (2070 kPa)** at **225 deg F (107 deg C)**.
   d. End Connections: Male threaded or grooved.
   e. Lining: Inert and noncorrosive, propylene.

2.010 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A 674 or AWWA C105/A 21.5.

B. Material: High-density, crosslaminated polyethylene film of 0.004-inch (0.10-mm) or linear low-density polyethylene film of 0.008-inch (0.20-mm) minimum thickness.

C. Form: Sheet or tube.

D. Color: Black or natural.

PART 3 - EXECUTION

3.01 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.02 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
2. Install piping as indicated unless deviations from layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

K. Make changes in direction for piping using appropriate branches, bends, and long-sweep bends.

1. Do not change direction of flow more than 90 degrees.
2. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

    a. Reducing size of drainage piping in direction of flow is prohibited.

L. Lay buried building piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Maintain swab in piping and pull past each joint as completed.

M. Install piping at the following minimum slopes unless otherwise indicated:

1. Building Storm Drain: 2 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 1 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
2. Horizontal Storm Drainage Piping: 2 percent downward in direction of flow.

N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

O. Install steel piping according to applicable plumbing code.

P. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

Q. Install aboveground ABS piping according to ASTM D 2661.

R. Install aboveground PVC piping according to ASTM D 2665.

S. Install underground ABS and PVC piping according to ASTM D 2321.

T. Install engineered controlled-flow drain specialties and storm drainage piping in locations indicated.

U. Install underground, ductile-iron, force-main piping according to AWWA C600.

1. Install buried piping inside building between wall and floor penetrations and connection to storm sewer piping outside building with restrained joints.
2. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
3. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

V. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."

1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

W. Install force mains at elevations indicated.

X. Plumbing Specialties:

1. Install backwater valves in storm drainage gravity-flow piping.

a. Comply with requirements for backwater valves specified in Section 221423 "Storm Drainage Piping Specialties."

2. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping.

a. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
b. Comply with requirements for cleanouts specified in Section 221423 "Storm Drainage Piping Specialties."

3. Install drains in storm drainage gravity-flow piping.

a. Comply with requirements for drains specified in Section 221423 "Storm Drainage Piping Specialties."

Y. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

Z. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

AA. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

BB. Install escutcheons for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.03 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.

C. Hubless, Cast-Iron Soil Piping Coupled Joints:

1. Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.

1. Cut threads full and clean using sharp dies.
2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
c. Do not use pipe sections that have cracked or open welds.

E. Join copper tube and fittings with soldered joints according to ASTM B 828 procedure. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

F. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fittings. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

G. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

H. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 appendices.

3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 appendices.

I. Joint Restraints and Sway Bracing:

1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:

a. Provide axial restraint for pipe and fittings **5 inches (125 mm)** and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
b. Provide rigid sway bracing for pipe and fittings **4 inches (100 mm)** and larger, upstream and downstream of all changes in direction 45 degrees and greater.
c. Provide rigid sway bracing for pipe and fittings **5 inches (125 mm)** and larger, upstream and downstream of all changes in direction and branch openings.

3.04 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Drainage Piping: Unshielded, nonpressure transition couplings.
3. In Aboveground Force-Main Piping: Fitting-type transition couplings.
4. In Underground Force-Main Piping:

a. NPS 1-1/2 (DN 40) and Smaller: Fitting-type transition couplings.
b. NPS 2 (DN 50) and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric nipples.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges.
4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.05 VALVE INSTALLATION

A. General valve installation requirements for general-duty valve installations are specified in the following Sections:

1. Section 220523.12 "Ball Valves for Plumbing Piping."
2. Section 220523.13 "Butterfly Valves for Plumbing Piping."
3. Section 220523.14 "Check Valves for Plumbing Piping."
4. Section 220523.15 "Gate Valves for Plumbing Piping."

B. Shutoff Valves:

1. Install shutoff valve on each sump pump discharge.
2. Install gate for piping NS 2 (DN 50) and smaller.
3. Install gate valve for piping NPS 2-1/2 (DN 65) and larger.

C. Check Valves: Install swing-check valve, between pump and shutoff valve, on each sump pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
2. Install backwater valves in accessible locations.
3. Comply with requirements for backwater valves specified in Section 221423 "Storm Drainage Piping Specialties."

3.06 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for hangers, supports, and anchor devices specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:

    a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Install hangers for cast-iron soil tubing and piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Install hangers for ABS and PVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting, valve, and coupling.

F. Support vertical cast-iron to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent, but as a minimum at base and at each floor.

G. Support vertical ABS and PVC piping with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.07 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
2. Install horizontal backwater valves with cleanout cover flush with floor.
3. Comply with requirements for backwater valves cleanouts and drains specified in Section 221423 "Storm Drainage Piping Specialties."

D. Connect force-main piping to the following:

1. Storm Sewer: To exterior force main.
2. Sump Pumps: To sump pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance.

F. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.08 IDENTIFICATION

A. Identify exposed storm drainage piping.

B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.09 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

    a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

3. Test Procedure:

    a. Test storm drainage piping, except outside leaders, on completion of roughing-in.
    b. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.

4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

C. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials.

    a. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

D. Piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.010 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.011 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground storm drainage piping NPS 6 (DN 150) and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Copper Type DWV tube, copper drainage fittings, and soldered joints.
5. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
6. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
7. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

C. Aboveground, storm drainage piping **NPS 8 (DN 200)** and larger shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Copper Type DWV tube, copper drainage fittings, and soldered joints.
5. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
6. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

D. Underground storm drainage piping NPS 6 (DN 150) and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed caulking materials; and caulked joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, cast-iron, hubless-piping couplings; and coupled joints.
3. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

E. Underground, storm drainage piping NPS 8 (DN 200) and larger shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed caulking materials; and caulked joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, cast-iron, hubless-piping couplings; and coupled joints.
3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Cellular-core, sewer and drain series, PVC pipe; PVC socket fittings; and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

F. Aboveground storm drainage force mains NPS 1-1/2 and NPS 2 (DN 40 and DN 50) shall be any of the following:

1. Hard copper tube, Type L (Type B) copper pressure fittings, and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.

G. Aboveground storm drainage force mains NPS 2-1/2 to NPS 6 (DN 65 to DN 150) shall be any of the following:

1. Hard copper tube, Type L (Type B) copper pressure fittings, and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.
3. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
4. Fitting-type transition couplings if dissimilar pipe materials.

H. Underground storm drainage force mains NPS 4 (DN 100) and smaller shall be any of the following:

1. Hard copper tube; Type L (Type B) wrought-copper pressure fittings; and soldered joints.
2. Ductile-iron, mechanical-joint piping and mechanical joints.
3. Ductile-iron, push-on-joint piping and push-on joints.
4. Ductile-iron, grooved-joint piping and grooved joints.
5. Fitting-type transition coupling for piping smaller than NPS 1-1/2 (DN 40) and pressure transition coupling for NPS 1-1/2 (DN 40) and larger if dissimilar pipe materials.

I. Underground storm drainage force mains NPS 5 (DN 125) and larger shall be any of the following:

1. Hard copper tube; Type L (Type B) wrought-copper pressure fittings; and soldered joints.
2. Ductile-iron, mechanical-joint piping and mechanical joints.
3. Ductile-iron, push-on-joint piping and push-on joints.
4. Ductile-iron, grooved-joint piping and grooved joints.
5. Pressure transition couplings if dissimilar pipe materials.

END OF SECTION 221413

SECTION 22 14 23 - STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Roof drains.
2. Miscellaneous storm drainage piping specialties.
3. Cleanouts.
4. Backwater valves.
5. Trench drains.
6. Channel drainage systems.

B. Related Requirements:

1. Section 076200 "Sheet Metal Flashing and Trim" for penetrations of roofs.
2. Section 078413 "Penetration Firestopping" for firestopping roof penetrations.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.04 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.01 METAL ROOF DRAINS

A. Cast-Iron, General-Purpose Roof Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Jay R. Smith Mfg. Co.
b. Josam Company.
c. MIFAB, Inc.

d. Wade; a subsidiary of McWane Inc.
e. WATTS.
f. Zurn Industries, LLC.

2. Standard: ASME A112.6.4.
3. Must utilize 4 bolts for securing to underdeck clamp, 3 bolt models are not acceptable.
4. See Plumbing Fixture Schedule on plans for more details.

2.02 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Downspout Adaptors:

1. Description: Manufactured, gray-iron casting, for attaching to horizontal-outlet, parapet roof drain and to exterior, sheet metal downspout.
2. Size: Inlet size to match parapet drain outlet.
3. See Plumbing Fixture Schedule on plans for more details.

B. Downspout Boots:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. J.R. Hoe & Sons Inc.
b. Neenah Foundry Company.

2. Description: Manufactured, ASTM A 48/A 48M, gray-iron casting, with strap or ears for attaching to building; NPS 4 (DN 100) outlet; and shop-applied bituminous coating.
3. Size: Inlet size to match downspout and NPS 4 (DN 100) outlet.
4. See Plumbing Fixture Schedule on plans for more details.

C. Conductor Nozzles:

1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
2. Size: Same as connected conductor.
3. See Plumbing Fixture Schedule on plans for more details.

2.03 CLEANOUTS

A. Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Jay R. Smith Mfg. Co.
b. Josam Company.
c. MIFAB, Inc.

d. Sioux Chief Manufacturing Company, Inc.
e. Tyler Pipe; a subsidiary of McWane Inc.
f. Wade; a subsidiary of McWane Inc.
g. WATTS.
h. Zurn Industries, LLC.

2. Standard: ASME A112.36.2M.
3. Size: Same as connected branch.
4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
5. Closure Plug Size: Same as, or not more than, one size smaller than cleanout size.
6. See Plumbing Fixture Schedule on plans for more details.

B. Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Jay R. Smith Mfg. Co.
b. Josam Company.
c. MIFAB, Inc.
d. Tyler Pipe; a subsidiary of McWane Inc.
e. Wade; a subsidiary of McWane Inc.
f. WATTS.
g. Zurn Industries, LLC.

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
5. Closure Plug:

a. Drilled and threaded for cover attachment screw.
b. Size: Same as, or not more than, one size smaller than cleanout size.

6. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
7. Wall Access: Round, copper-alloy, or stainless-steel wall-installation frame and cover.
8. See Plumbing Fixture Schedule on plans for more details.

C. Test Tees:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Jay R. Smith Mfg. Co.
b. Josam Company.
c. MIFAB, Inc.

d. Tyler Pipe; a subsidiary of McWane Inc.
e. WATTS.
f. Zurn Industries, LLC.

2. Standard: ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301.
3. Size: Same as connected drainage piping.
4. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or no-hub, cast-iron soil-pipe test tee as required to match connected piping.
5. Closure Plug: Countersunk or raised head, brass.
6. Closure Plug Size: Same as, or not more than, one size smaller than cleanout size.

2.04 BACKWATER VALVES

A. Cast-Iron, Horizontal Backwater Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Jay R. Smith Mfg. Co.
b. Josam Company.
c. MIFAB, Inc.
d. Tyler Pipe; a subsidiary of McWane Inc.
e. Wade; a subsidiary of McWane Inc.
f. WATTS.
g. Zurn Industries, LLC.

2. Standard: ASME A112.14.1.
3. Size: Same as connected piping.
4. Body Material: Cast iron.
5. Cover: Cast iron with bolted or threaded access check valve.
6. End Connections: Hub and spigot or no hub.
7. Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.
8. Extension: ASTM A 74, Service class; full-size, cast-iron soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Cast-Iron, Drain-Outlet Backwater Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Jay R. Smith Mfg. Co.
b. Josam Company.
c. WATTS.
d. Zurn Industries, LLC.

2. Standard: ASME A112.14.1.
3. Size: Same as floor drain outlet.
4. Body Material: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.

5. Check Valve: Removable ball float.
6. Inlet: Threaded.
7. Outlet: Threaded or spigot.

C. Plastic, Horizontal Backwater Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Canplas LLC.
   b. IPS Corporation.
   c. NDS Inc.
   d. Oatey.
   e. Plastic Oddities.
   f. Sioux Chief Manufacturing Company, Inc.
   g. Zurn Industries, LLC.

2. Standard: ASME A112.14.1.
3. Size: Same as connected piping.
4. Body Material: PVC.
5. Cover: Same material as body with threaded access to check valve.
6. Check Valve: Removable swing check.
7. End Connections: Socket type.

2.05 TRENCH DRAINS

A. Trench Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Jay R. Smith Mfg. Co.
   b. Josam Company.
   c. MIFAB, Inc.
   d. Tyler Pipe; a subsidiary of McWane Inc.
   e. WATTS.
   f. Zurn Industries, LLC.

2. Standard: ASME A112.6.3.
3. See Plumbing Fixture Schedule on plans for more details.

2.06 CHANNEL DRAINAGE SYSTEMS

A. Narrow, Sloped-Invert, Polymer-Concrete, Channel Drainage Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. ABT, Inc.

b. ACO USA.
c. Jay R. Smith Mfg. Co.
d. Mea-Josam Div.
e. MultiDrain Systems, Inc.
f. Polycast: Hubbell Power Systems, Inc.

2. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.

a. Channel Sections: Narrow, interlocking-joint, sloped-invert, polymer-concrete modular units with end caps.

1) Include rounded bottom, with built-in invert slope of 0.6 percent and with outlets in number, sizes, and locations indicated.
2) Include extension sections necessary for required depth.
3) Dimensions: 5-inch (127-mm) inside width and 9-3/4-inch (248-mm) inside depth. Include number of units required to form total lengths indicated.
4) Frame: Galvanized steel or cast iron for grates.

b. Grates: Manufacturer's designation "heavy duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.

1) Material: Ductile iron.
2) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.

c. Covers: Solid ductile or cast iron, of width and thickness that fit recesses in channel sections, and of lengths indicated.
d. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
e. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

B. Narrow, Level-Invert, Polymer-Concrete, Channel Drainage Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABT, Inc.
b. ACO USA.
c. Mea-Josam Div.
d. Polycast: Hubbell Power Systems, Inc.

2. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.

a. Channel Sections: Narrow, interlocking-joint, precast, polymer-concrete modular units with end caps.

1) Include rounded bottom, with level invert and with outlets in number, sizes, and locations indicated.
2) Dimensions: 5-inch (127-mm) inside width and 9-3/4-inch (248-mm) inside depth. Include number of units required to form total lengths indicated.
3) Frame: Galvanized steel or cast iron for grates.

b. Grates: Manufacturer's designation "heavy duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.

1) Material: Ductile iron.
2) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.

c. Covers: Solid ductile or cast iron, of width and thickness that fit recesses in channel sections, and of lengths indicated.
d. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
e. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

C. Wide, Level-Invert, Polymer-Concrete, Channel Drainage Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABT, Inc.
b. ACO USA.
c. Mea-Josam Div.
d. Polycast: Hubbell Power Systems, Inc.

2. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.

a. Channel Sections: Wide, interlocking-joint, precast, polymer-concrete modular units with end caps.

1) Include flat or rounded bottom, with level invert and with outlets in number, sizes, and locations indicated.
2) Dimensions: 8-inch (203-mm) inside width and 13-3/4-inch (350-mm) inside depth. Include number of units required to form total lengths indicated.
3) Frame: Galvanized steel or cast iron for grates.

b. Grates: Manufacturer's designation "heavy duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.

1) Material: Ductile iron.
2) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.

c. Covers: Solid ductile or cast iron, of width and thickness that fit recesses in channel sections, and of lengths indicated.
d. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
e. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.

1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
2. Install expansion joints, if indicated, in roof drain outlets.
3. Position roof drains for easy access and maintenance.

B. Install downspout adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.

C. Install downspout boots at grade with top 12 inches (305 mm) above grade. Secure to building wall.

D. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.

E. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:

1. Use cleanouts the same size as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
3. Locate cleanouts at minimum intervals of 50 feet (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
4. Locate cleanouts at base of each vertical storm piping conductor.

F. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

G. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

H. Install horizontal backwater valves in floor with cover flush with floor.

I. Install drain-outlet backwater valves in outlet of drains.

J. Install test tees in vertical conductors and near floor.

K. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.

L. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface unless otherwise indicated.

M. Assemble channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

N. Install through-penetration firestop assemblies for penetrations of fire- and smoke-rated assemblies.

1. Comply with requirements in Section 078413 "Penetration Firestopping."

3.02 CONNECTIONS

A. Comply with requirements for piping specified in Section 221413 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.03 FLASHING INSTALLATION

A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

3.04 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221423

SECTION 22 33 00 – WATER HEATERS

GENERAL

DESCRIPTION OF WORK

Tankless gas fired hot water heater.

QUALITY ASSURANCE

The heater manufacturer shall provide the Owner with a two-year warranty. The manufacturer shall replace any equipment part that fails due to defective material or workmanship during the warranty period. The warranty shall begin at start-up of equipment.

SUBMITTALS

Shop drawings, project data and samples furnished by the manufacturer shall illustrate materials, equipment or workmanship, and establish standards by which the work will be judged. Submit in accordance with Division 1, Section 01300.

Product Data:

Submit manufacturer's catalog cuts, specifications, installation instructions, dimensioned drawings for each type of manufactured equipment specified herewithin.

Shop Drawings:

Show equipment, required factory and external piping and connections, valves, gauges, thermometers, sequence of operation, required for complete system operation.

Show space required for tube removal and service.

Provide complete wiring diagrams showing all field connections required for system operation.

Certifications:

Submit verification of code certificate for safety relief valve.

EQUIPMENT

Tankless GAS FIRED HOT WATER HEATER

Material

Tankless hot water heater shall supply a continuous flow of hot water at the temperature rise as scheduled on the drawing.

Unit shall have direct electronic ignition with not more than a three second delay between flow of water and flame ignition.

A means of setting output temperature shall be included in the manufactured product.

Heater shall have a digital temperature control integrally mounted to project through the front panel of the water heater. The outlet water temperature shall be adjustable from 96-180°F. The front panel temperature control shall also display fault codes if the water heater malfunctions to assist with servicing the water heater. No installation shall be required for the main temperature control.

Heater shall be direct vent design, using only outside air for combustion. The venting system shall be a coaxial design requiring a single hole through the outside wall or roof. Vent pipe fittings shall have internal gaskets for a tight seal to prevent leakage of flue products and combustion air.

Heater shall continuously monitor burner flame and modulate to match the heating requirements of the water flow. Temperature and flow sensors shall continually monitor the water flow and outlet water temperature and adjust the burner and combustion air blower to maintain temperature.

The tankless hot water heater shall have a flame rod sensor to indicate flame failure and boiling water protection.

Accessories

Venting shall be provided by the contractor as required by the tankless hot water heater manufacturer. Venting components and routing shall comply with the manufacturer's venting guidleines as found in the product documentation. Venting guideline shall take priority over drawings in cases of conflict.

AGA/ASME Pressure & Temperature relief valve with contractor piping to nearest floor drain.

Housekeeping pad, Equipment floor supports, unistrut, etc..

Sealed combustion system, taking only outside air for combustion and exhausting the flue gas with plastic pipe. Contractor shall furnish 3" or 4" PVC or CPVC pipe (per manufacturer and rating) to termination location as shown on the plans. Provide either sidewall or roof concentric termination kit maintaining a minimum of 10'-0" from all outside air intakes. All related intake air and exhaust gas shall be approved for zero clearance to any combustible surface.

Control panel shall be an integrated solid state temperature and ignition control device with integral diagnostics, LED fault display capability, and a digital display of temperature settings.

Provide all controls and accessories per the plans. Provide two separate controllers for 140 deg F system and 120 deg F system.

Provide identification per section 220553.

Manufacturers:

Rheem

Lochinvar

Laars

AO Smith

Execution

METHOD OF INSTALLATION

Contractor shall follow all manufacturer's instructions for installation, setup, and operation of the hot water heater. Contractor shall provide all required materials, accessories, components, and testing required, regardless of whether it is indicated on the drawings or elsewhere in these specifications.

END OF SECTION

SECTION 22 42 00 - PLUMBING FIXTURES AND ACCESSORIES

GENERAL

DESCRIPTION OF WORK

Plumbing Fixtures and Accessories

1. As shown on drawings Plumbing Fixture Schedule.

QUALITY ASSURANCE

The fixture manufacturer(s) shall provide the owner with a two year warranty. The manufacturer shall replace any equipment part that fails due to defective material or workmanship during the warranty period. The warranty shall being at start-up of fixtures.

SUBMITTALS

Submit product data, which shall include the following:

1. Submit manufacturer's catalog cuts, installation instructions, dimensional drawings for each type of manufactured equipment specified herein.

JOB CONDITIONS

Protect all work, materials, fixtures and equipment from damage. Cap or plug temporary openings. Deliver all new work to the owner clean and in operating condition. Keep work areas clear of debris. Promptly remove waste material from the premises.

GUARANTEE

The contractor guarantees all plumbing work against any defects due to faulty workmanship or material and that all new piping is free from foreign material, obstructions, holes or breaks of any nature.

The contractor guarantees the proper circulation and/or drainage of fluid in each piping system.

CLEANING

Clean fixtures prior to turning over to owner.

PRODUCTS

PLUMBING SPECIALTIES

Flexible Connections: Flexonics Series 400, or approved equal, braided flexible hose with screwed ends, seamless stainless steel bellows and stainless steel woven braid. Hose shall be of the length and pressure ratings, etc., as required for services and conditions encountered.

MV Water Mixing Valves:

Valve size and capacity as indicated on the drawings with a maximum pressure differential of 10 psi.

a. Leonard Type TM- 80-E Thermostat Mixing Valve or approved equal, for exposed piping with corrosion-resistant bi-metal thermostat directly linked to valve porting to control the intake of hot and cold water and compensate for supply temperature or pressure fluctuations, with adjustable limit stops, color-coded temperature scale, wall support, union angle checkouts with removable strainers on inlets, 1/2" tempering circulating by-pass, and rough bronze finish.

Thermal Expansion Absorber Tank: Amtrol Model AST Extrol or approved equal for potable water heaters, shall be of the positive fixed diaphragm type, factory pre-charged and field adjustable, with heavy duty Butyl diaphragm rigid polypropylene liner, and rust resistant baked epoxy finish outer shell, complete with NPT system connection and stainless steel air charge valve to facilitate on-site charging. Size and capacity as indicated on the drawings.

P-# Circulating Pump -- Domestic Hot Water: Refer to schedule on drawings.

DRAINS

Drains shall be per the on-drawing plumbing fixture schedule, or herein, at contractor's option.

Drains shall be manufactured by Zurn or Wade as hereinafter specified, Josam, JR Smith, approved equal.

DRAWING I.D.	MODEL NO.
R.D. Roof Drain	Zurn ZC-100-[RC] Dura coated iron body roof drain with roof sump receiver, under deck clamp, combination membrane flashing clamp/gravel guard, and low silhouette cast iron dome.
R.D. - Roof Drain	Z-100-RC with cast iron dome, body and grate, drain receiver, deck clamp, and primary and

secondary flashing

clamps.

All nickel bronze shall have polished satin finish.

Drains shall be sized as indicated on drawings.

FLASHING

Contractor shall flash around each vent pipe extending through roof, with 6 lbs. sheet lead. Flashing shall be installed 10 inches in all directions from pipe underneath roofing material and joined with wiped joint to piece of 6 lb. lead soil pipe, carried up, over and turned down into the top of pipe so as to form a permanent watertight joint, and to permit expansion.

All lead flashing shall be entirely painted with a good coat of black Asphaltum before installation.

Coordinate installation with roofing contractor.

LEAD SAFE PANS

Contractor shall furnish and install for all roof drains, and all clean-out covers and floor drains in floors above grade a 36"x36" 6 lb. sheet lead pan. All surfaces of pans shall be painted with a good coat of black Asphaltum before installation. Lead safe pans shall be watertight.

Coordinate roof drain installation with roofing contractor.

PLUMBING SPECIALTIES

Refer to the on-drawing plumbing fixture schedule which govern for models, or where not shown, refer to specifications below.

All plumbing specialties shall be furnished and installed per manufacturer's requirements. All work and material required to rough-in, connect-up and install specialties items shall be provided as required for proper operation. Items are specified by manufacturer's numbers as to the type and quality required.

Provide fixtures as indicated in the on-drawing plumbing fixture schedule or herein.

HB-Hose Bibb - Unfinished Areas: Chicago Faucets 998-293-6 rough chrome plated supply fittings with integral vacuum breaker, ¾" hose outlet and No. 1771 concealed loose key stop.

HB-Hose Bibb - Finished Areas: Chicago Faucet 998-293-6 chrome plated supply fitting with integral vacuum breaker, ¾" hose outlet and No. 1771 concealed loose key stop.

WH-Wall Hydrant: Wade W-8620-91 non-freeze, anti-siphon, wall hydrant with integral backflow preventer, ¾" hose outlet and nickel bronze face.

SF-Service Fittings: Chicago Faucet 782-VB-IS chrome plated supply fitting with integral vacuum breaker, ¾" hose outlet, bucket hook, wall brace and integral stops.

TP-Trap Primer: Sloan No. F-72-A1 trap primer assembly, installed in conjunction with Royal No. 113-3 flush valve, with 3/8" tubing and fittings to wall connection. Contractor to provide and install piping between wall fitting and drain trap.

BP-Backflow Preventer: Reduced Pressure Principle, Watt 909 Series or approved equal backflow preventer assembly for horizontal or vertical (up) installation. Unit shall be of bronze and stainless steel construction, complete with strainer, full port resilient seated shut-off and test cock ball valves, vent elbow and vent piping, air gap drain unit and drain piping. Maximum pressure differential through the unit shall not exceed 10 psig. Febco, Airgap, or approved equal.

GPR-Gas Pressure Regulators: Pressure regulating valves shall be of size and capacities indicated on the drawings. Pressure regulators shall be provided with full flow relief vented outside of the building. Gas pressure regulators shall be provided with inlet and outlet pressure gauges. Regulators shall be Rockwell, Fisher, or approved equal.

PRV Water Pressure Reducing Valves: Pressure reducing valves shall be factory set for required pressure and shall be provided with stainless steel or nickel alloy renewable seats, stainless steel strainer screens, high temperature diaphragms, and shall be rated at a minimum of 250 psig-wwp.

Valves 2" and smaller shall have bronze bodies with screwed ends, Watts U5 or approved equal.

Valves 2½" and larger shall have iron bodies with flanged ends, Watts 1223S, 2230S or 127W or approved equal.

Flexible Connections: Flexonics Series 400, or approved equal, braided flexible hose with screwed ends, seamless stainless steel bellows and stainless steel woven braid. Hose shall be of the length and pressure ratings, etc., as required for services and conditions encountered.

UB Ice Maker Utility Box: Plastic Oddities Inc. part No. IB-20 or approved equal. Water supply recessed enclosure, size 6"x6" with 8"x10" face plate, fabricated of high density polyethylene, containing city water connection adapter and shut-off valve.

MV Water Mixing Valves:

Valve size and capacity as indicated on the drawings with a maximum pressure differential of 10 psi.

Powers No. 11 Self-Operating Temperature Regulator or approved equal, three-way automatic valve for mixing domestic hot and cold water to maintain constant, pre-set temperature delivery. Valve shall be complete with sensing element, element well and thermometer at discharge.

Valves shall have bronze body with composition disc and union connections for sizes through 2".

Valve sizes 2½" through 4" shall have iron body, bronze trim and flanged ends.

Leslie-Eventemp model GTRCK Self-contained Temperature Regulating or approved equal, 250 lb. cast iron body, single seated valve, for mixing cold water into domestic hot water supply to maintain constant, pre-set temperature delivery. Valve shall be complete with calibrated dial, heavy gage copper flexible liquid filled thermo-element tubing, brass element bulb and thermo bulb casing. Provide down-stream thermometer with ranageability 200-1.

Leonard Type TM- 80-E Thermostat Mixing Valve or approved equal, for exposed piping with corrosion-resistant bi-metal thermostat directly linked to valve porting to control the intake of hot and cold water and compensate for supply temperature or pressure fluctuations, with adjustable limit stops, color-coded temperature scale, wall support, union angle checkouts with removable strainers on inlets, 1/2" tempering circulating by-pass, and rough bronze finish.

Washer/Dryer Connection Utility Box: Guy Gray model BNWBED-200-20TS or approved equal. Size 9"x14-3/4" leak proof box fabricated of all-welded stainless steel with overflow guards, 2" drain hose connection, satin plated faucets, 20 amp. single electrical grounding receptacle and dryer outlet. UL listed.

Thermal Expansion Absorber Tank: Amtrol Model AST Extrol or approved equal for potable water heaters, shall be of the positive fixed diaphragm type, factory pre-charged and field adjustable, with heavy duty Butyl diaphragm rigid polypropylene liner, and rust resistant baked epoxy finish outer shell, complete with NPT system connection and stainless steel air charge valve to facilitate on-site charging. Size and capacity as indicated on the drawings.

Tank shall be installed on the cold water side o of the water heater, connected between heater and backflow preventer, and charged with air pressure as required by the system operating pressure. Tank shall be ASME constructed and rated for not less than 125 psi working pressure and 200 degree working temperature.

SV Shower Mixing Valves: Shall be Pressure Balancing or Thermostat mixing. Valves shall comply to the codes, and ANSI/ASME A112.18.1 Standard required design flow rate of 4 GPM and a pressure of 20 psi.

P-# Circulating Pump -- Domestic Hot Water: Bell & Gossett bronze body model ECOCIRC E3 series or approved equal, in-line horizontal, oil-lubricated type. Specifically designed and guaranteed for quiet operation, suitable for 125# working pressure and 225 degrees operating temperature. Motor shall be of the drip-proof, sleeve bearing, rubber mounted construction. Motor shall have built-in thermal overload protection.

Pump shall have a capacity of 6 GPM at 25 ft. head when operating at 1750 rpm, 120 volts, single phase, 60 hertz.

Circulating pump shall be controlled via of return aquastat with digital readout for temperature setting.

Interceptors and Separators: See waste specialties.

PLUMBING FIXTURES

Furnish plumbing fixtures as indicated on the on-drawing plumbing fixture schedule.

All plumbing fixtures, equipment and related accessories shall be furnished and installed in a neat, finished and uniform manner. All work and material required to rough-in, connect up and install supply, drain, waste, soil and vent piping shall be provided as required for proper operation. This shall include plumbing fixtures, equipment and accessories and includes items furnished under other sections or furnished by the Owner. Fixtures, equipment and accessories are specified by manufacturer's numbers as to the type and quality required. (NOTE: The architect may reject any fixture, equipment item or accessory which, in his opinion is not of the quality or type specified.). Specified manufacturers and approved equal manufacturers are as follows.

ITEM OR EQUIPMENT	SPECIFIED MANUFACTURE	APPROVED EQUAL MANUFACTURER
Vitreous China Fixtures	Toto	Kohler
Wall Hung Lavatory		Elijer
Countertop Lavatory		American Standard
Water Closet		
Urinal		
Stainless Steel Sinks	Elkay	Just
Hand Wash Sink		Acorn
Bar Sink		
Kitchen Sink		
Hospitality Sink		
Scullery Sink	Just	Elkay
Molded Stone Fixtures	Fait	
Animal Room Sink		
Precast Receptors	Fiat	Williams
Drinking Water Coolers	Halsey Taylor	Oasis
		Elkay
Porcelain Enameled Cast Iron Fixtures	American Standard	Kohler
		Eljer

Whirlpool Bath		
Supply Fittings & Faucets	Chicago Faucet	American Standard
		T&S Brass
Sensor Operated	Just	Bradley
		Delany
		Sloan
		T&S Brass
Single Lever	Moen	Delta
Waste Fittings	McGuire	Dearborn
Stops & Supplies		Brasscraft
		Powers
Flush Valves	Toto	Delany
Trough Washdown		Sloan
Floor Drain Valve		
Trap Primer		
Precast-Terrazzo	Fait	Williams
Service Basin		Bradley
Shower Floor		
Water Coolers		
Wall Mounted	Elkay	Oasis
Recessed	Hasley Taylor	Haws

		Elkay
Shower Head, Arm & Escutcheon	Symmons	Leonard Chicago Faucet
Pressure Balancing Mixing Valves	Symmons	Leonard Powers
Thermostatic Mixing Valves	Leonard	Powers Symmons
Water Closet Seats	Toto	Church Beneke Olsonite
Carriers	Wade	Zurn Smith Josam
Garbage Disposals	In-Sink-Erator	Kitchen Aid General Elec
Emergency Equipment		
Shower/Eye Wash	Guardian	Haws
Eye Wash		Bradley
Shower (Ceiling)		Speakman

Tubs & Shower		
Tub/Shower Module (Handicapped)	Aqua Glass	Crane/Fiat
Shower Module (Handicapped)	Aqua Glass	Crane/Fiat
Shower Cabinet	Fiat	
Hot Water Mixing Valves		
3-Way Valve Body	Powers	
Single seated body	Leslie	
Thermostatic with bypass	Leonard	
Drains		Wade, Zurn Josan
Roof	Zurn	

All vitreous china and enameled cast iron fixtures shall be white in color, acid resisting, without blemishes and the best of their respective kind.

All stainless steel fixtures shall be 18 gauge, type 302 nickel bearing stainless steel, with brushed satin finish and sound deadening undercoat.

Plumbing trim utilized shall be provided with renewable seats and replaceable internal working components.

Each water closet shall be provided with a seat, seats shall be white, elongated open front, with combination self-sustaining check hinges.

Unless otherwise specified, each lavatory shall be provided with: McGuire ST7-LK angle stops and M65 3/8"x12" flexible risers; McGuire 8902 adjustable, semi cast brass P-trap (1¼" inlet, 1½" outlet) with ground swivel joint, cleanout plug, slip inlet and 17 gauge 1½" trap arm. Provide McGuire 158WC loose key straight stop supplies for wheelchair lavatories.

Unless otherwise specified, each sink shall be provided with: McGuire ST7-LK angle stops and M66 3/8" x 20" flexible risers; McGuire 151 basket strainer, 1½" x 4" 17 gauge tailpiece with brass locking and coupling nuts, McGuire 8912 adjustable, semi cast brass P-trap (1½") with ground swivel joint, cleanout plug, slip inlet and 17 gauge 1½" trap arm. Provide additional strainers, tailpieces and continuous waste pieces for multiple compartment sinks as required.

All fixtures shall be substantially supported in an approved manner. Furnish and install adjustable carriers with legs, floor bases, bearing plates, support arms or rods as required for all wall hung fixtures. Anchor carriers to floor and brace to wall construction for substantial support. Carriers shall be required to fit fixtures furnished. Verify available space for carriers and provide appropriate carrier to fit space and building construction. Install all supports before walls are finished. The Contractor shall be responsible for a period of one year following final acceptance of the building, for the loosening of any plumbing fixture and any subsequent damage to the building caused by the fixture or as a result of leaks in piping, and shall promptly make repairs to the building, shall replace or repair fixture carriers as deemed necessary by the Architect at no additional cost to the contract.

All fixtures shall be set true and level. Install all fixtures in accordance with manufacturer’s requirements and at recommended heights unless otherwise indicated.

Fixtures that are wall hung or butt a wall shall have adjacent edges and surfaces factory ground true and square.

All spaces between fixtures and finished surfaces shall be caulked and pointed square with an approved white silicone sealant resulting in a neat and smooth appearance.

All exposed fixture trim shall be polished chrome plated brass.

The contractor shall be responsible for the protection and cleanliness of all fixtures, equipment and accessories.

Set all countertop fixtures with caulking compound and seal edge of rim with an approved white silicone sealant for a neat, smooth appearance.

All precast receptors and basins shall be of standard color and set level in a bed of cement mortar per manufacturer's requirements.

All water supply fittings shall close with pressure and have model trim.

Refer to the on-drawing plumbing fixture schedule for models, accessories, etc. They govern for bidding.

The following fixture and equipment list specifies the basic fixture or item, each of which shall be provided with applicable accessories for its proper operation.

Refer to on-drawing fixture schedule.

Cafeteria and Restaurant Fixtures

Per the on-drawing schedule.
Advanced TABCO
Elkay

Ice Maker rough-in boxes – per on drawing schedule

Laundry Equipment rough-in boxes – per on drawing schedule

Water Softeners – See Water softener specification.

execution

FIXTURE BRANCH PIPING

Size piping as indicated on drawings and diagrams, but not smaller than indicated in the "Branch Fixture Schedule".

Provide air chambers at all locations where supply pipes terminate. All air chambers shall be full size of supply piping and 15" long except for flush valves shall be 18" long.

All exposed connections and fittings shall be chrome plated brass. All supplies, stops, escutcheons, tailpieces, traps and trap arms within cabinets shall be considered exposed.

Provide chrome plated cast brass set-screw escutcheons for all exposed fixture supply and waste piping.

All fixture supply and waste piping through wall shall be rigidly supported. Supports in contact with copper piping shall be copper plated or fire retardant plastic.

SHOCK ABSORBERS

Shock absorbers: Furnish and install sealed bellows shock absorbers in the water supply to each bank of plumbing fixtures in main toilet rooms as shown on drawings and in make-up water connections where solenoid valves are installed as shown on drawings. Shock absorbers shall be sized and rated for number of fixtures in each bank in accordance with the Plumbing and Drainage Institute (PDI) Standard PDI-WH201.

Manufacturers:

Wade: Wade Series W "Shokstop"
Zurn
Josam
Sioux Chief

END OF SECTION 224200

SECTION 22 42 50 - TRECH DRAINS

GENERAL

WORK INCLUDED

This Specification, together with the accompanying drawings, is intended to be the means of requiring this Contractor to provide all labor, materials, tools, equipment, services and weather protection required for the complete installation, ready to operate of "Plumbing Work" as shown on the drawings and specified herein.

Furnish and install as shown on the drawings and as specified herein.

Building Drains

Floor Drains - Furnish and install all work incidental to the foregoing items to be performed under this contract, such as:

All plugged tee and valved outlets

All cutting and patching of work of any nature unless otherwise specified herein

All pipe and equipment hangers, platforms, support bases, anchors, guides, expansion loops, vibration eliminators, etc., unless otherwise specified herein

All required final connections to equipment

All cleaning, disinfecting and testing

REGULATORY REQUIREMENTS

The entire plumbing installation shall comply fully with requirements of all applicable State and local laws, codes and ordinances.

The work shall also comply with all applicable requirements of the National Fire Protection Association (NFPA), Occupational Safety and Health Act (OSHA), the International Plumbing Code and the Environmental Protection Agency (EPA).

A reference to an ANSI or ASTM Standard shall indicate that the article shall conform to that standard in all respects (including material, manufacture, handling, dimensions, and test procedure).

SUBMITTALS

Submit shop drawings in accordance with General Requirements, Division 1, Section 013300, and as follows:

Submit catalog data and descriptive literature, as applicable, for all equipment, fixtures, and specialty items in accordance with the Conditions of the Contract and obtain approval of materials before delivery to job site.

Shop drawings shall be coordinated with equipment supplied by other Contractors and the Owner.

Submit a bound copy of all approved shop drawings, together with complete parts lists and operating and maintenance instructions for all equipment furnished under this Section.

JOB CONDITIONS

Inspect existing site conditions affecting the work before submitting bid.

Take all measurements for plumbing work and shop drawings with all other contractors affected and make any necessary offsets required to conceal piping and to clear equipment, structural members and other obstructions.

Protect all work, materials, fixtures and equipment from damage. Cap or plug temporary openings. Deliver all work to the owner clean and in perfect condition. Keep work areas clear of debris. Promptly remove waste material from the premises.

GUARANTEE

The contractor guarantees all plumbing work against any defects due to faulty workmanship or material and that all piping is free from foreign material, obstructions, holes or breaks of any nature.

The contractor guarantees the proper circulation and/or drainage of fluid in each piping system.

Upon written notice from the Architect or Owner, the contractor shall promptly remedy, without cost to the Owner, any defects occurring within a period of one (1) year from the date of final acceptance.

CLEANING AND DISINFECTING

Piping systems shall be cleaned and disinfected as hereinafter specified. All equipment, temporary piping, chemicals, etc., as required shall be furnished by the Contractor.

Domestic Water Systems: All system piping and equipment shall be thoroughly and completely flushed with cold city water. Completely drain the systems and fill with a solution of Sodium or Calcium Hypochlorite, 100 parts per million, completely relieve the system of all air. Allow the solution to stand for eight (8) hours and then drain and follow with a clear water flush for a sufficient period of time to remove all traces of hypochlorite odor. Disinfecting chemicals shall not be introduced into existing piping systems.

Immediately prior to final inspection the Contractor shall make a final cleanup of dirt and refuse resulting from his work and shall make the premises broom clean. The Contractor shall clean all material and equipment installed under the contract. Damaged finishes shall be touched-up and restored to their original condition.

PIPING TESTS

All piping shall be tested, leaks repaired and systems retested until proven tight before backfilling, concealing or insulating pipe.

Test drainage and vent systems with water or air in accordance with requirements of the Uniform Plumbing Code and all applicable local Codes. Water test may be applied to entire drainage systems or sections of systems. All openings shall be tightly closed in section to be tested except at highest opening. All portions of systems shall be subjected to a minimum of 10 feet head of water. Water must have been in the system 15 minutes prior to inspection. Air test in accordance with the Uniform Plumbing Code may be used at Contractor's option.

Hydrostatically test entire domestic water system to 100 psig or higher pressure as required by local Code.

Work shall include all testing equipment.

equipment

trench DRAINS

Drains shall be manufactured by ABT, Zurn, or ADC.

DRAWING I.D.	MODEL NO.
Trench Drain (TD-1)	Polydrain

Precast Trench Drain - The precast trench shall be manufactured using polyester polymer concrete with the following material properties when tested:

Property ASTM	Test Method	Value
Compressive Strength Minimum	ASTM C579	17,000 psi
Bending Strength	ASTM C580	4,000 psi Minimum
Tensile Strength	ASTM C307	2,000 psi Minimum
Moisture Absorption Maximum	ASTM C140	0.2%
Chemical Resistance	ASTM C267	Pass
Freeze/Thaw w/o weight loss Cycles Minimum	ASTM C666	1,600 Number of
Resistance to Fungi Growth	ASTM G21	Zero (0) Rating Mold
UL/ULC Listed- Flame Spread	UL-723	Class A

The trench consisting of 39.19” (1 meter) or 19.56” (1/2 meter) channels with nominal 6” (155mm) outside width, 4 “ (100mm) inside width. Pre-sloped channels shall have a standard slope of 0.6% with radius bottom. Non-sloping channels must have written approval by engineer prior to installation. Channels shall have tongue and groove joints. Grate lock down slots shall have polyethylene vibration dampening inserts. All channels must have full length anchoring ribs for a positive mechanical lock with the surrounding concrete.

Sidewall Extensions – Sidewall extensions for channels may be used for hydraulic performance or to maintain the standard slope of 0.6% in greater trench run lengths. Sidewall extensions shall be composed of similar material and thickness as the channels and shall have tongue and groove joints.

Frame & Grate: #2512AF: Epoxy coated ductile iron conforming to ASTM A-536 with a minimum of 0.21Ft^2 /L Ft (.064m^2/Lm) open area. Grates shall meet a minimum 620 psi proof load per AASHTO M-306 test modified by utilizing a 9” x 3” load plate. Frames shall be a minimum of .188” (4.77mm) thick. The frames shall have .25” dia. x 3” long (minimum) anchors spaced no more than 17” (431.8mm) on center. Frames shall be independent of the channels. Frames and grates shall seat into channels without rocking and shall be locked to the channel using a zinc plated steel 5/16 – 18 UNC bolt and zinc plated steel toggle bar system with a bolt torque of 10in/lb. Frames and grates shall be made in U.S.A., and shall conform to the FHWA's "Buy America" policy 23 CFR 635.410(b) and Federal Acquisitions Regulations (FAR) 52.225 “Buy American Act”.

Provide Catch basin 12” wide with matching continuous grate. Catch basin shall be provided with stainless steel trash basket and integral side trap (other models with this not available option shall provide trap as noted below).

All trench drains, except where specified with integral traps, shall be provided with separate cast iron traps.

All grates shall be ductile iron with black epoxy finish.

Drains shall be sized as indicated on drawings.

END OF SECTION

SECTION 23 05 00 – MECHANICAL GENERAL PROVISIONS

GENERAL

DESCRIPTION OF WORK

Provide items, articles, materials, operation and methods required by drawings and specifications including labor, equipment, supplies and incidentals necessary for completion of work in Division 23 – Heating Ventilating and Air Conditioning.

Design Engineer, hereinafter abbreviated D/E shall mean the Engineering firm, Wellner Architects+Engineers, 1627 Main St., STE 100, Kansas City, MO, Telephone (816) 221-0017. Contact person: Cory Wilson.

RELATED DOCUMENTS

The General Provisions described herein, together with the conditions of contract, and the General Requirements of Division 1, apply to the work in Division 23 – Heating Ventilating and Air Conditioning.

This Section is hereby made a part of all other sections of Division 23 – Heating Ventilating and Air Conditioning, as if repeated in each.

QUALITY ASSURANCE

All permits and licenses that are required by governing authorities for the performance of shall be procured and paid for by the Contractor.

All work shall be performed in compliance with all applicable and governing safety regulations including the regulations of the Occupational and Safety Health Act. All safety lights, signs and guards required for performance of work shall be provided by the Contractor.

All work shall conform to the requirements of all applicable codes, ordinances and regulations including the rules and regulations of the National Electrical Code, the National Fire Protection Association, the International Mechanical Code, OSHA and all State and Local laws, codes and ordinances.

Laws, codes, ordinances and regulations shall take precedent excepting only where the work called for by the drawings and specifications exceeds by quality and quantity.

Fixtures, appliances, equipment and materials which are subject to Underwriter's Laboratory tests shall bear such approval.

Mechanical and electrical designs are based on the requirements for the specified manufacturers listed on the equipment schedules. Conduit, disconnects, motor starters, breakers, fuses and wire sizes are selected on basis of scheduled equipment. Increased current requirements necessitating larger wire, breakers, switches, etc., to accommodate any alternate or substitute manufacturer's equipment, other than as shown on drawings shall be provided without any increase in contract price by contractor furnishing the equipment.

Manufacturers, where specifically called for, must provide factory tests, unit installation observations, unit start-up and tests, etc., as specified, and submit signed reports to the Engineer upon completion of these services. Subletting of these services will not be permitted. Shop drawing submittals shall be accompanied with a letter of certification by the manufacturer that the specified services shall be provided. Failure to do so shall be cause to reject the shop drawing submittals.

The contract drawings are in part schematic and intended to convey the scope of work and indicate the general layout, design and arrangement. The Contractor shall follow these drawings in the layout of his work and shall consult general construction drawings, electrical drawings and all other drawings for this project, and shall verify all existing site conditions to determine all conditions affecting the work shown or specified. The contract drawings are not to be scaled and the Contractor shall verify spaces in which the work is to be installed.

Follow drawings in laying out work, check drawings of other trades to verify spaces in which work will be installed, and maintain maximum headroom and space conditions at all points. Where headroom or space conditions appear inadequate, Engineer shall be notified before proceeding with installation.

Work in cooperation with one another to fit piping and ductwork into the structure as job conditions may demand. All final decision as to right of way and run of pipe, ducts, etc. to be made by Engineer or his representative.

All work shall be performed by trained mechanics of a particular trade involved and done in neat and workmanlike manner as approved by Engineer.

Work shall be performed in cooperation with other trades and scheduled to allow timely and efficient completion of project.

Furnish other trades advance information on locations and sizes of frames, boxes, sleeves and openings needed for work, and also furnish information and shop drawings necessary to permit other trades affected to install their work properly without delay.

Where there is evidence that work of one trade will interfere with work of other trades, all trades shall assist in working out space conditions to make satisfactory adjustments.

Work installed before coordinating with other trades causing interference with work of such other trades shall be changed to correct such condition without increase in contract price and as directed by Engineer.

Where specific details and dimensions are not shown on the drawings, the Contractor shall take measurements and make layouts for the proper installation of the work and coordination with all other work on the project. In case of any discrepancies between the drawings and the specifications, it shall be assumed, by the signing of the Contract, that the higher cost (if any difference in costs) is included in the contract price, and the Contractor shall perform the work in accordance with the drawings or with the specifications, as determined and approved by the Engineer.

The Contractor shall be responsible for a scheduled sequence in performing the work so that it will not interfere with the Owner's operation in the existing building. Before any work is started, the Contractor shall consult with the Engineer and Owner and arrange a satisfactory schedule.

Make temporary alterations as required to execute work so that all operations and services in the existing building are maintained with the minimum possible interruption.

Temporary shut-downs shall be segregated and shall be of the shortest possible duration. All facilities shall be kept in continuous operation unless specific permission to the contrary is granted by Owner.

Definitions:

"Piping" includes, in addition to pipe, all fittings, valves, sleeves, hangers, and other supports and accessories related to such piping.

"Concealed" means hidden from sight in chases, furred spaces, shafts, hung ceilings, embedded in construction, or in crawl spaces.

"Exposed" means not installed underground or "concealed" as defined above.

The words "furnish and install", "provide", "furnish", "install", or equivalent words are used or are understood, to mean the Contractor shall furnish and completely install the system, service, equipment, or material named, together with other associated devices, equipment, material, wiring, piping, etc. as required for a complete operating installation, and conforming to the manufacturer's standards and recommendations.

It is the intent of these specifications and drawings to call for finished work, tested and ready for operation.

All apparatus, appliances, materials or work not shown on drawings, but mentioned in specifications, or vice versa, and/or all incidental accessories necessary to make work complete and ready for operation, even though not specified or shown on drawings, shall be furnished and installed without increase in contract price.

Should there be discrepancies or questions of intent, refer matter to Engineer in writing for decision before ordering any equipment or materials or before starting any related work.

SHOP DRAWINGS AND SAMPLES

Shop drawings, project data and samples furnished by the Contractor shall illustrate materials, equipment or workmanship, and establish standards by which the work will be judged.

Shop Drawings and Samples shall be submitted to the Engineer by a letter of transmittal. The party making the submission shall be named on Shop Drawing/Sample and also in the letter of transmittal.

When Shop Drawing submissions are in the form of loose pages (8½" x 11") they shall be submitted in sets assembled in portfolio binders showing on the covers or first page inside, a complete list of contents. A minimum of 7 sets of each submission are required, however, additional copies may be requested.

The Contractor shall review, stamp with his approval and submit, with reasonable promptness and in orderly sequence so as to cause no delay in the work or in the work of any other contractor, all Shop Drawings and Samples required by the Contract Documents or subsequently by the Engineer as modifications. Shop Drawings and Samples shall be properly identified as specified or as the Architect/Engineer may require. At the time of submission, The Contractor shall inform the Architect/Engineer in writing of any deviation in the Shop Drawings or Samples from the requirements of the Contract Documents.

Except in the case of brochures, catalogue cuts and the like, shop drawings shall be in the form of a reproducible print(s) (sepia). In every case, the submittal shall consist of one sepia of each shop drawing and two (2) black line prints of the same. Each print shall be made from the original shop drawing tracing. The transparency shall be capable of producing clean, clear black and white prints.

Contractor shall stamp each sepia and black line print (shop drawing) the same. He shall also stamp each brochure, sample and the like. Special Note: Every page with project information shall be stamped. In every instance, the document shall be reviewed by the Contractor and shall also be signed by the Contractor indicating that the document has been reviewed, and that it is approved by the Contractor. The submittals will not be reviewed without the Contractor's approval stamp and signature.

The Contractor's approval stamp and signature shall signify that the Contractor has checked the submittals. Any submittals which have not been checked shall be returned to the Contractor for checking, approval stamp, signature, and resubmittal for compliance with the contract documents. After review of the submittals they will be returned to the Contractor with one of the following remarks checked:

No Exceptions Taken	*SUBJECT TO CONTRACT DOCUMENTS.*
Note Corrections	*SUBJECT TO CONTRACT DOCUMENTS RESUBMISSION NOT REQUIRED.*
Revise and Resubmit	*REVISE, RESUBMISSION REQUIRED.*
Rejected	*NOT APPROVED.*

Upon receipt of exhibits submitted and marked for resubmittal the Contractor shall cause the marked corrections and corrections that may be contained in the Architect/Engineer transmittal letter to be made on each submittal. All such corrections shall be circled, numbered, and dated to permit prompt reviewing upon resubmittal to the Architect/Engineer. Upon receipt of each submittal now marked:

The Contractor shall cause submittals to be distributed to the respective contractors and suppliers as is necessary for proper performance of work.

At the time of submission, the Contractor shall inform the Engineer in writing of any deviation in the exhibits submitted from the requirements of the Contract.

The Engineer will review exhibits submitted with reasonable promptness so as to cause no delay, but only for conformance with the design concept of the Project and with the information given in the Contract. The Engineer's review of a separate item shall not indicate review of an assembly in which the item functions. The Engineer's review is not intended to indicate approval of dimensions or quantities.

Contractor shall make any corrections required by the Engineer and shall resubmit the required number of submittals until further resubmittals are no longer required.

Engineer's review of submittals shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract unless the Contractor has the Engineer's approval in writing of such deviation at the time of submission and the Owner's Representative has given written notice to the specific deviation; nor shall the Engineer's review relieve the Contractor from responsibility for errors or omissions in the submitted exhibits.

No portion of the work requiring a submittal shall be commenced until the Engineer has reviewed the submission. All such portions of the work shall be in accordance with reviewed submittals.

OPERATION AND MAINTENANCE MANUALS

In addition to the requirements specified in Division 1, the Contractor at the project's completion shall submit a complete system operating and maintenance manual. O&M manual shall be organized into systems and shall contain the manufacturer's complete detailed operating and maintenance instructions with equipment data for each piece of installed equipment furnished under this project. Manual at a minimum shall include the following:

Manual shall be composed of typed instructions sheets with large drawing sheets (not reduced) folded in with reinforced margin, shall have a post binder system so that sheets can be easily substituted, and shall have a hard cover.

Include in O&M manuals Manufacturers written maintenance instruction for each different piece of equipment provided and installed on this project.

Include spare parts list for each major piece of equipment furnished for the project including but not limited to controls, boilers and accessories.

Provide a comprehensive list of maintenance procedures for preventative maintenance and troubleshooting; disassembly, repair and reassemble; aligning and adjusting instructions.

products

GENERAL

All materials and equipment shall be new and shall bear manufacturer's name, model number and other identification marking.

All materials and equipment shall be standard product of manufacturer regularly engaged in production of required type of material or equipment for at least 5 years (unless specifically exempted by Engineer) and shall be manufacturer's latest design having published properties.

FIRESTOPPING

Firestopping is defined herein as the process of furnishing and installing a material, or combination of materials, in various constructions to maintain an effective barrier against the spread of flame, smoke, and gasses and to retain the integrity of time-rated construction. It shall be used in specific locations as specified hereinafter.

Piping penetrations through floor slab and through time-rated partitions of fire walls;

Opening between floor slabs and curtain walls, including inside hollow curtain walls at the floor slab;

Penetrations of vertical service shafts;

Openings and penetrations in enclosures with time-rated fire doors;

Other locations where specifically shown on drawings or where specified in other sections of these specifications;

Openings in non-time-rated construction shall be closed with a compacted fill of ¾ lb. density fiberglass and then sealed gas tight.

Material of firestopping shall be asbestos free and capable of maintaining an effective barrier against flame, smoke and gases in compliance with the requirements of ASTM E 814, UL NO. 1479. Fire-stopping material shall be manufactured by 3M barrier products. Products shall be capable of providing a cold smoke and water seal. When exposed to temperatures exceeding 250ºF these products shall rapidly expand up to ten times the original volume.

Installation of fire stopping shall be in accordance with the manufacturer's recommendations and requirements. Surface to be in contact with firestopping shall be cleaned of dirt, grease, oil, loose materials, rust, or other substance that may affect proper fitting or the required fire resistance.

Firestopping materials shall provide an effective barrier regardless of the geometric configurations of the void spaces. Firestopping materials for filling voids in floors having openings of four (4) inches or more shall be installed to support the same load as the floor is designed to support, unless the area is protected by a permanent barrier preventing loading or traffic on the fire-stopped area.

At a minimum fire stop systems shall be designed to achieve a 2-hour F rating with an emphasis on also achieving a 2-hour T rating. In addition to fire and thermal protection, fire stop systems shall be designed to provide a barrier to the transmission of smoke and toxic fumes.

A firestop system as defined by these specifications shall consist of fire barrier products, in certain configuration and quantity, to meet the intent of the specifications above. Fire protection products include:

3M fire barrier CS-195 composite sheet
3M fire barrier moldable putty
3M fire barrier CP 25WB caulk
3M fire barrier FS-195 wrap/strip

Firestop systems for floor and chase penetrations shall be installed on both sides of the penetration (top and bottom) (in and out). Firestop systems shall be symmetrically installed on both sides and shall meet or exceed all requirements for AT&T standard practices.

ELECTRICAL EQUIPMENT

General: Unless specifically specified or shown otherwise, the Contractor shall furnish required motors, variable speed drives with controls, and disconnect switches for equipment furnished under this Division. Motors, drives, and associated controls, and disconnecting equipment shall be provided where indicated and as required for operation of the equipment being furnished. Motors shall be designed for full voltage starting unless otherwise specified or noted on drawings and shall be suitable for continuous duty at 40 C. ambient. All motors shall be selected, designed and fabricated in conformance with the requirements of NEMA-MG-1 standard.

All motors shall be NEMA Design B induction motors with voltage and phase scheduled on drawings. Motors shall be equipped with Class F insulation, rated with a service factor of 1.15 and nominal full-load efficiency within 1.5% of the maximum values provided by the National Electrical Manufacturers Association Standard 12.6C in publication MG 1. The motor efficiency testing standards for all motors is IEEE Standard 112-1984, “Standard Test Procedure for Polyphase Induction Motors and Generators”. All motors shall have a 2% - 5% power factor improvement over typical standard efficient motors. Motors shall comply with the frame size assignments of NEMA MG 13-1984. Motor nameplate horsepower ratings shall not be exceeded when the equipment is operating within the limits of the design conditions specified. The motor loading shall not exceed the motor service factor rating on start-up conditions or at the equipment maximum load point.

Rating: Motor rating, service factor and nameplate data shall conform to the requirements of NEMA-MG-1 standards. Motor nameplate horsepower ratings shall not be exceeded when the equipment is operating within the limits of the design conditions specified. The motor loading shall not exceed the motor service factor rating on start-up conditions or at the equipment maximum load point.

Nameplate data shall conform to NEMA MG 1 requirements. For motors of one horsepower and greater, the following additional nameplate data shall be included:

Manufacturer's identification number
Frame size number
Insulated system class designation
Service factor
Locked-rotor KVA code letter
Starting limitations (if any)
Hazard classification (if approved)

a. Design and construction of each motor shall be coordinated with the driven equipment requirements.

Service factor - All motors of one horsepower and greater shall be furnished with a service factor of 1.15 in accordance with NEMA-MG-1.

Enclosures - All motors shall be self-cooled. Motors for indoor service shall have drip-proof enclosures. Motors for outdoor service shall be totally enclosed and shall have all exposed metal surfaces protected, where practical, with a corrosion resistant polyester paint or coating. Exposed unpainted and uncoated metal surfaces shall be of a corrosion resistant material. All self-ventilated open type motors and the fan hoods of totally enclosed fan cooled motors shall meet NEMA MG 1 requirements for a fully guarded machine. Totally enclosed motors shall be furnished with cast iron frames, bearing brackets and terminal housings. Fan cooled motors shall have fans fabricated of corrosion resistant metal and cast iron fan covers.

Bearings for fractional horsepower motors shall be designed to operate in any position or angle. One-piece sleeve bearings with wick lubrication shall be furnished where available. Ball bearings shall be furnished where sleeve bearings are not available and where axial thrust loads exceed 20 pounds.

Bearings for motors of one horsepower and greater shall be oil lubricated sleeve bearings. If motor frame size is such that sleeve bearings are not available, bearings shall be grease lubricated rolling element type, self-lubricated and re-greaseable.

DISCONNECT SWITCHES

Material - Disconnect switches shall be NEMA type HD (Heavy Duty) quick-make, quick-break disconnect switches not furnished by others with equipment and where indicated on drawings or where required by Code. Switches shall be fusible or non-fusible as called for or as required. Switches shall have NEMA I enclosure unless otherwise specified or called for otherwise on drawings. Switches shall have door interlock and shall be padlockable in "open" and "closed" position. Where indicated for use in motor circuits utilizing VSDs switch shall be furnished with interlock contacts for interface with VSD, preventing operation of VSD when load is disconnected.

Reference E-series drawings and Division 26 for disconnect switches provided by electrical contractor. If not shown and required it is assumed the equipment manufacturer is providing it. If not, the contractor shall be responsible for all providing including all labor for installation.

MOTOR STARTERS

Starters shall be in accordance with NEMA ICS, UL 508 and the following paragraphs:

All starters installed indoors shall be in a NEMA 1 enclosure and all starters installed outdoors shall be in a NEMA 4 enclosure. Enclosures shall be designed for surface mounting unless otherwise indicated.

Each starter shall have a nameplate on the cover. Nameplates shall be made of laminated black and white plastic with the white on the outside. Lettering shall be bold, not less than 1/4 inch square, engraved through the white outside layer so that the letters appear black. Nameplate wording will be furnished as called for on drawings or as approved by the Owners Representative.

Magnetic starters shall include 480 volt, 3-phase, 60 hertz contractors with three manual reset thermal overload relays, 120 volt operating coils, and 480 to 120 volt dry type control transformers complete with one secondary lead fused and the other secondary lead grounded. Large size starters which require line voltage to energize the operating coils shall be equipped with auxiliary contractors for use in the operating coil circuit. These contractors shall be operated from the 120 volt circuit of the control transformers. Reduced voltage starters shall be closed transition auto transformer type equipped with taps for 50, 65 and 80 percent of full voltage. Two speed starters and reversing starters shall be mechanically and electrically interlocked so that only one set of contacts can be closed at any one time. Contractors shall have a current rating in accordance with NEMA standard ICS.

Two each normally open and normally closed interlock contacts shall be furnished with each starter as indicated. Additional interlocks shall be as called for on drawings.

Three thermal overload relays of the bimetallic strip or euthenic alloy type shall be furnished with each motor starter. Thermal overload relay heaters shall be sized to protect their associated motors of the circuits from damage due to overload. Provisions shall be made for manually resetting the thermal relay without opening the starter cover.

Control Transformers shall have 60 hertz ratings permitting operation at a primary voltage ranging from 208 to 240 volts. Assuming 208 volts on the primary terminals, each control transformer shall maintain a minimum potential of 105 volts at its secondary terminals during starter coil inrush, while simultaneously serving an additional load of 100 volt amperes at 50 percent power factor. Control transformers shall be mounted in the enclosure with the magnetic starter.

Each magnetic starter shall be equipped for control from local remote push-button or control switch, or other pilot devices as called for on drawings. All necessary internal wiring for this feature shall be supplied and connected to terminal blocks located to provide easy connection to the external control wiring.

A push to test running pilot light shall be provided and mounted in the cover of each magnetic starter to indicate when the motor is in operation. The light shall be of the transformer type with a 6 volt bulb and a red color cap.

Hand-Off-Auto" Selector Switch Units shall be provided and mounted in the cover of the starter as indicated in these specifications and as indicated on drawings. Units shall be heavy-duty, oil-tight and shall be complete with contact blocks and legend plates. Momentary contact "start-stop" push-buttons shall be provided with an auxiliary contact for use in the holding circuit.

Schematic Diagrams shall be as indicated on drawings or as approved by the Contracting Officer.

Each combination starter where indicated on drawings shall include a magnetic starter, as specified hereinbefore, and a disconnect switch or a fusible disconnect switch complete with fuses.

Each fusible disconnect switch unit shall include one 3 pole, 600 volt, quick-make, quick-break, manually operated switch connected in series with one replaceable dual element fuse per switch pole. The switch and fuse elements shall be sized according to the following:

Starter Size	Fuse Clip Size

00	30 ampere
0	30 ampere
1	60 ampere
2	60 ampere
3	100 ampere
4	200 ampere
5	400 ampere

Fuses shall be UL 198D Class K5, 600 volt, and dual element type. Fuses shall have a thermal element that restricts the temperature rise to 280° F. and an element of low peak type that limits the let through fault current. Fuses shall be rated at 200,000 amperes RMS symmetrical interrupting capacity and shall have a minimum time delay of 10 seconds at 500% of rating as specified hereinbefore.

A manual operating handle shall be mounted in the cover of each starter to operate the disconnect switch. The handle shall have provisions to lock in the open position with one or more padlocks. The cover and switch shall be interlocked so that the cover cannot be opened normally when the switch is in the closed position. Provisions shall be made for overriding this interlock.

Motor starters shall be wall or column mounted not more than six feet above the floor or mounted on the equipment if readily accessible from the floor or roof. Each starter shall be labeled on the cover as specified hereinbefore. The labeling shall be done with black letters on a white background. Letters are to be 1/4 inch high.

Nameplates - All major equipment items shall have a permanent stainless steel nameplate. Nameplates shall include the applicable items in the following list:

Manufacturer's size and type
Serial number
Design capacity
Design pressure
Design speed
Design temperature
Design static pressure "w.c."
Motor horsepower and RPM

A permanently attached rotation arrow shall be provided on all items of rotating equipment.

EXECUTION

CUTTING AND PATCHING

The responsibility for any cutting of construction, which is required for the installation work, shall be by the Contractor. The Contractor shall coordinate with the Owner before any cutting and obtain approval from the Engineer and the Owner prior to any cutting.

Where openings for work within this Division are provided under other sections of the specifications, this Contractor shall be responsible for locating and providing the proper dimensions for all such openings.

Cutting shall be done with extreme care and in such a manner that the strength of the structure will not be endangered. Wherever possible, openings in concrete or masonry construction shall be by concrete saw or rotary core drill. Openings in any construction shall be cut the minimum size required for the installation of the work.

Adequate protection shall be provided to prevent damage to adjacent areas and to prevent dust from spreading to adjacent areas.

The use of jackhammers will not be permitted.

Where openings or holes are cut in existing construction and the cutting breaks existing electrical circuitry or control circuitry, or communications, conduit and wiring, then it shall be the responsibility of the Contractor to have the circuitry, conduit and rewiring re-routed and to complete the circuitry as required and as approved by the Owner. Temporary completion shall be provided where necessary before the permanent re-routing and completion work is finished. All costs for this work shall be the responsibility of the Contractor and no additions will be allowed to the Contract price.

Before any cutting, patching, or finishing work is started, dust and moisture protection shall first be installed as required to protect adjacent construction and equipment and to prevent dust spreading from the immediate area where work is being performed.

After any work is installed through any opening in walls, partitions, ceilings, or floors, the opening around the work shall be patched to match the existing construction, and the openings around pipe sleeves, between pipes and sleeves, and around ductwork shall be sealed watertight through floors and shall be sealed fireproof and smoke tight through floors, walls, partitions and ceilings.

Where existing work is removed from openings in existing construction and the opening is not to be reused for new work, the opening shall be filled and patched to match existing adjacent construction and to be watertight for floors and to be fireproof and smoke tight for floors and all other construction.

No structural member shall be cut without the approval of the Consultant, and all such cutting shall be done in a manner directed by him.

ELECTRICAL COORDINATION

All electrical products and installation used on this project shall conform unless otherwise specifically noted, to applicable standards of the National Electrical Manufacturers Association, NFPA 70, Division 26 of these specifications, and shall also be listed by Underwriter's Laboratories, Inc. and/or other agencies, as required.

Electrical power sources and motor connections for all equipment shall be provided as specified within Division 26 of these specifications. All control wiring, safety interlock wiring, and temperature control system wiring required shall be furnished and installed as specified within these specifications. The control wiring shall include the furnishing and installation of all conduit, boxes, fittings, devices, accessories, wire, and connections required for complete and properly functioning systems. All wiring shall be installed in conduit, and all splices and connections shall be made in approved type enclosures or boxes.

If motors or controls are not shown on the Electrical Drawings, it has been assumed that these motors and controls have been wired as part of a piece of package equipment, or that control wiring will be run by the Contractor.

Reports: The Contractor shall submit to the Engineer, after mechanical systems are completely installed and operating under normal load conditions and prior to final acceptance of the project, four (4) copies of tabulated report on each piece of mechanical equipment motor and motor starter. The tabulated reports shall show the following information:

Mechanical equipment identification on which motor and starter is used

Motor nameplate horsepower, full load amperes, and voltage

Motor nameplate service factor and temperature rise

Actual (metered) motor running amperes and voltage

Motor starter nameplate: HP rating and voltage

Motor starter thermal overload protection unit current rating, manufacturer's name and manufacturer's catalog number marked on thermal units.

NOISE AND VIBRATION

Contractor shall be responsible for the installation of all equipment in such a manner as to control the transmission of noise and vibration from any installed equipment or system, so the sound level shall not exceed NC35, in any occupied space. Contractor shall be responsible for the correction of any objectionable noise in any occupied area due to improperly installed equipment.

TEMPORARY UTILITIES, SERVICES AND CONNECTIONS

The Contractor shall provide temporary electric power for construction purposes in accordance with all Codes and Ordinances and as required by projects. All temporary equipment, materials and connections required for the temporary services shall be furnished and installed by the Contractor. At the completion of the project or at such time as the temporary services are no longer needed, the Contractor shall remove all temporary equipment, materials, and connections and shall restore facilities to permanent finished conditions. Contractor may obtain temporary service from the existing building.

Temporary wiring connections and facilities shall be installed as required, so that all spaces, fixtures, devices, equipment, and circuits that are required to stay in operation do so, and so that interruptions in the use of any space, device, fixtures or piece of equipment can be held to the absolute minimum time possible.

Interruptions in existing utilities, services, or in the electrical circuitry and facilities shall be scheduled and sequenced as hereinbefore specified in this section of the specifications, and sequencing shall also conform to specific requirements as specified in other sections of the specification or as indicated on the drawings. The scheduling and sequencing shall be coordinated in advance with the Owner and Architect and shall be as approved by these parties. Even though a schedule is approved, the Owner shall also be notified immediately prior to any interruption in any electric facilities and circuits so that alternative arrangements can be made.

INSPECTION

Each bidder shall inspect the site as required for knowledge of existing conditions and failure to obtain such knowledge shall not relieve the successful bidder of the responsibility to meet existing conditions in performing the work under the contract.

Where new work cannot be installed without changes in existing plant, facility or systems or where it is indicated on drawings to rework an existing installation, this contract shall include alterations to existing work as required to install new work. Additions to the contract cost will not be allowed because of this Contractor's failure to inspect existing conditions.

Where existing power, lighting, or control circuitry is broken by removal of existing devices, equipment, or fixtures, or by demolition work, cutting or removal of existing building construction, and where the existing circuitry is required by remaining devices or equipment to stay in service, then the circuitry shall be completed as required by job conditions.

Existing conditions indicated on the drawings are taken from the best information available on previous contract drawings and from visual site inspection and are not to be construed as "As-Built" conditions, but are to indicate the intent of this work. It shall be the responsibility of the Contractor to verify all existing conditions at the project site and to perform the work as required to meet the existing conditions and the intent of this work indicated.

TESTING

All electrical equipment furnished under this Division shall be adjusted and tested by this Contractor. Motors and other equipment furnished by others, to which electrical connections are made under this Division, shall be checked for short circuit and open circuits before energizing. Motors shall be checked for proper phasing and rotation. The thermal overload protection devices shall be checked in all motor starters, and equipment and all protection device size, motor nameplate full load amperage, and voltage rating for protection of the motor shall be listed (include equipment designation, rating of heater, motor nameplate horsepower, full load amps and voltage) and 4 copies of list shall be submitted to the Architect.

Mechanism of all electrical equipment shall be checked, adjusted and tested for proper operation. Protective devices and parts shall be checked and tested for specified and required application and adjusted as required. Adjustable parts of all lighting fixtures and electrical equipment shall be checked, tested and adjusted as required to produce the intended performance.

Completed wiring systems shall be free from short circuits and after completion, perform tests for insulation resistance in accordance with the requirements of the National Electrical Code.

The Contractor shall be held responsible for the operation, service and maintenance of electrical equipment during construction and prior to acceptance by the Owner. All electrical equipment shall be maintained in the best operating condition. Operational failure caused by defective material an/or labor furnished under this Division shall be immediately corrected. Architect shall be immediately notified of any operational failures caused by defective material and/or labor covered under other Divisions or furnished by others.

START-UP

All labor for the installation of material and equipment furnished under this Division shall be done by experienced mechanics of the proper trade and all workmanship shall be first class and in compliance with the specific requirements of drawings and specifications.

All material and equipment provided under this Division shall be installed under competent supervisory service furnished by the Contractor. Where necessary, this shall include the services of special erection and operation personnel.

The Contractor shall furnish all hoists, scaffolds, staging, runways, tools, machinery and equipment required for the performance of work.

Dirt and refuse resulting from the performance of the work shall be removed from the premises daily as required (broom clean) to prevent accumulation and the Contractor shall cooperate in the maintaining of reasonably clean premises at all times.

Immediately prior to the final inspection, Contractor shall clean all material and equipment. Dirt, refuse and stains shall be removed from all surfaces and damaged finishes restored to original condition.

TRAINING

The Contractor shall furnish all services as required for adequate verbal and printed instructions to the Owner and the Owner's operating and maintenance personnel for operation and maintenance of all equipment and systems installed under this Division. Three complete copies of service manuals in hardback binder shall be furnished at the end of the project in accordance with the General Conditions of the specifications. The manuals shall include printed operating and maintenance instructions for systems and equipment specified under this Division, all approved shop drawings and all manufacturer printed data.

When the work is complete and at a time designated by the Owner's designated Representative, the Contractor shall furnish the services of a qualified instructor to instruct the Owner's personnel in the operation and maintenance of the systems and equipment.

The bound copies of the operating and maintenance manuals shall be used during the verbal instructions.

END OF SECTION 230500

SECTION 23 05 01 – MECHANICAL PROJECT COORDINATION AND INSTALLATION

GENERAL

CONTRACTOR'S USE OF PREMISES

Confine operations at site to areas and limits permitted by law, ordinances, permits; Contract Documents and General Conditions.

Protection and safekeeping of products stored on premises is responsibility of contractor supplying product.

Deliveries and unloading shall be scheduled to prevent traffic congestion blocking of access or interference with Work. Arrange deliveries to avoid larger accumulations of materials than can be suitably stored at site.

Contractor shall pay for, or satisfactorily repair, all damages incident to their Work, to sidewalks, streets, other public or private property, or to any public utilities occurring during period of work under this Contract.

HAZARDOUS MATERIALS

Submit Material Safety Data Sheets for all materials furnished in this project defined as hazardous by NFPA. All requirements of the Material Safety Data Sheets shall be implemented and followed judiciously when hazardous materials are installed or otherwise used.

All hazardous materials shall be stored and used (mixed, applied, etc.) in strict accordance with the OSHA Standards, Safety Data Sheets and the Owner's Safety standards.

Refrigerants, nitrogen, welding gas, paints, varnish, volatile oils, etc., shall be stored in a room having good ventilation and containing no other material, or in metal lockers or barrels well away from structures or other combustible materials.

WELDING AND CUTTING

Special precautions shall be taken to reduce fire hazards where electric or gas welding or cutting work or soldering is done and suitable fire extinguishing equipment shall be maintained near such operations. Before proceeding with any electric or gas welding or cutting or soldering work in or adjacent to the existing building the Contractor shall obtain a permit from either the Engineer or Owner. The permit shall be issued by its authorized supervisor or representative certifying compliance with conditions set out in the permit pertaining to welding and cutting operations.

PRODUCTS

NOT USED.

EXECUTION

NOT USED.

END OF SECTION 230501

SECTION 23 05 16 – MECHANICAL EXPANSION COMPENSATION

GENERAL

DESCRIPTION OF WORK

Flexible pipe connectors

Flexible ductwork connections

SUBMITTALS

Submit shop drawings for all flexible connectors in accordance with Division 1.

EQUIPMENT

PIPING FLEXIBLE CONNECTIONS

Material - Flexible pipe connectors for installation in supply and return water connections to water coils in air handling units shall be multiple arch TFE T62 Teflon with Monel reinforcing rings, control units and 150# ANSI flanged ends. Connectors shall have minimum live length of not less than recommended by the connector manufacturer for vibration isolation.

Manufacturer:

Resistoflex
Mason Industries.

FLEXIBLE DUCT CONNECTIONS

Material - Flexible duct connections shall be made with 30 oz. non-combustible, waterproof and mildew-resistant double polychloroprene coated glass fabric. Connections shall be not less than 4" long, shall have suitable metal collar frame at each end and shall be made with not less than 1" slack in material to prevent transmission of vibration.

At flanged equipment connections, bolt companion flange, continuously brazed to minimum 3 inch extension collar and minimum same gage as connecting duct.

Manufacturer:

Duro Dyne Corp.: Metalfab Canvas
Flow-Flex Eng. Co.: Fabric Connectors
Ventfabrics, Inc.: Ventfab Metaledge

EXECUTION

METHOD OF INSTALLATION

Provide flexible pipe connectors in the suction and discharge connections, the supply and return water connections of coils in all air handling units; and elsewhere where shown on drawings.

Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Install flexible pipe connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Rigidly anchor pipe to building structure; provide pipe guides so that movement takes place along axis of pipe only. Install expansion joints along axis of pipe.

Furnish and install flexible duct connections for equipment supported on vibration isolation.

END OF SECTION 230516

SECTION 230523 – HVAC VALVES

GENERAL

DESCRIPTION OF WORK

HVAC Valves:

Ball Valves
Butterfly Valves
Globe Valves
Check Valves
Pressure and Temperature Relief Valves

QUALITY ASSURANCE

Valves shall be of the same manufacture throughout, where possible. Manufacturer's name and pressure rating shall be located on outside of valve.

Unless noted otherwise, cut-off valves shall be ball valves or butterfly valves. Flow control (balancing) valves shall be per specification section 232116 “Hydronic Specialties.”

Cut-off valves used in water and water/glycol systems including chilled, process chilled, condenser, heating and process heating shall be ball valves for 2" size and smaller, and shall be butterfly valves 2½" size and larger.

SUBMITTALS

Submit shop drawings in accordance with General Requirements, Division 1 and as follows:

Submit copies of valve ordering schedule for approval before ordering valves.
Submit detailed shop drawings indicating make, model, location, type, size, and pressure rating.

EQUIPMENT

BALL VALVES

Ball valves shall be manufactured to comply with MSS SP 110 and shall be 3-piece type. Valves shall be all bronze (B-584 or B-62) with stainless steel ball, full port and shall be designed for 150 PSI, 600 WOG; working temperature range of at least 0°F. to 300°F. Ball valves shall be three-section assembly with Double-O ring seal and removable center section with replaceable Teflon, TFE seats. Ball valves shall have blow-out proof stem with high extended stem to provide for insulating, lever type handle with vinyl grip and 90° stop on the extended stem. All valve stem housings shall be of length to receive up to 1½" thick insulation and shall have NIB seal valve extension.

Manufacturer

Ball valve manufacturers for HVAC applications

Nibco
Stockham
Jamesbury

BUTTERFLY VALVES:

Butterfly valves shall be manufactured to comply with MSS SP68.

The valve body shall be carbon steel construction, lug style design, suitable for bidirectional dead-end service at rated pressure without use of downstream flange. The valve shall have a CWP rating of 285 psig at 100°F. The lug style body shall be drilled and tapped for isolation and removal of downstream piping. The valve body shall have an extended neck of sufficient length such that 2 inch, pre-molded fiberglass insulation and jacketing can be installed up to and around the valve neck. The neck extension shall allow sufficient clearance for valve operator without damage to the insulation.

The valve disk and stem shall be of stainless steel construction, with reinforced PTFE seats.

Manufacturer

Keystone HS2
Bray
DeZurik
NIBCO

GLOBE VALVES:

Globe valves in piping 2" and smaller shall bronze, rated at 150 psig-swp and provided with a union bonnet, composition disc and screwed ends.

Globe valves in copper tubing shall be bronze, rated at 300 psig-wog. and provided with a screwed bonnet, composition disc, solder ends.

Globe valves in piping 2½" and larger shall be iron body, bronze mounted, rated at 125 psig-swp and provided with a composition disc, outside screw and yoke and flanged ends.

Manufacturer(s): Basis of Design.

Globe valves in piping 2" and smaller shall be Stockham B-22.
Globe valves in copper tubing may be Stockham B-14T.
Globe valves in piping 2½" and larger shall be Stockham G-514T.
Equals include NIBCO and McDonnell

CHECK VALVES

Check valves in HVAC applications shall be spring-loaded, non-slamming, silent closing, with renewable seat and disc guided at both ends, stainless steel or bronze trim, and rated for not less than 250 psi cold water working pressure at temperature up to not less than 100°F. Valves shall close off bubble-tight. Valves 1½" and smaller shall have bronze body and screw ends, and valves 2" and larger shall have globe style body of carbon steel, ductile iron, or semi-steel, and with ANSI Class 150 pound flanged ends.

Manufacturer

Mueller Steam Specialty Co
Keystone
Metraflex

PRESSURE & TEMPERATURE RELIEF VALVES

Material - Pressure and temperature relief valves shall be designed, constructed and rated to ASME Code. Valves shall have a capacity at pressure indicated on drawings, in Btu's/Hr. of not less than capacity of units which they protect, and they shall have test levers. Extend relief line full size and end over drain.

Manufacturer

Watts

McDonnell
NIBCO

EXECUTION

METHOD OF INSTALLATION

Valves shall be installed within each system to provide the required flow control and to provide isolation for inspection, maintenance and repair of each piece of equipment and each main and branch service loop. The foregoing shall apply whether or not valves are shown on drawings. Valves shall also be installed in other locations shown on drawings. Each valve shall be installed so as to be easily accessible for operation and visual inspection after construction is complete.

A union connection shall be installed within two feet and on each end of a screw end valve (Reference Section 232113 for piping unions). Valves and specialty items shall be rated for not less than the cold water working pressure and the test pressure specified for each piping system.

END OF SECTION - 230523

SECTION 23 05 29 – MECHANICAL SUPPORTS, ANCHORS AND SEALS

GENERAL

DESCRIPTION OF WORK

Piping Hangers and Supports

Duct Hangers and Supports

Roof Mounted Curbs and Equipment Supports

PRODUCTS

PIPING HANGERS AND SUPPORTS

Provide factory-fabricated horizontal piping hangers, clamps, attachments and supports in compliance with ANSI SP-69 and ANSI SP- 89. Select hangers and supports sized to exactly fit pipe size for bare piping, and to exactly fit around pipe insulation with saddle and shield for insulated piping. Hangers in contact with copper pipe shall be copper plated.

Unless specified otherwise, pipes shall be hung with malleable iron, split ring hangers or clevis hangers not less than 1/8" thick. Strap type hangers shall not be acceptable. Roller type hangers shall be used where required or shown to allow for movement of pipes by expansion. Hangers shall have rods and turnbuckles of required length. Suspension shall be from suitable steel supports fastened to overhead construction or steel wall brackets. Hangers and supports shall be installed so that pipes are run parallel and evenly spaced.

Anchors in concrete construction shall be threaded compound type or Phillips self-drilling type of sufficient size to adequately support the load.

Manufacturer:

Hangers and supports:

Mason Mfg. Co.
Kindorf Mfg.
Unistrut Mfg., Inc.
Fee Mfg.

Saddles and shields:

Pipe Shields, Inc.

DUCT HANGERS AND SUPPORTS

Material - Duct hangers shall be galvanized steel band iron or 1¼" x 3/16" angle and 3/8" rods. Wall supports for ductwork shall be galvanized steel band iron or fabricated angle bracket. Support vertical ductwork at floor with rolled 1¼" x 3/16" structural steel angle.

Duct Supports: Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts straight, plumb, free of sags and vibration, and to prevent buckling. Support ductwork from building structure where not otherwise indicated, anchor with bolts, concrete inserts, welded studs, C-clamps, or special beam clamps with support as indicated in the SMACNA Standards. Anchor methods other than listed shall receive prior approval from Owner before using. Support vertical ducts, at every floor, 12 foot maximum spacing, by attachment to adjacent vertical structural surfaces or by direct bearing at floor penetrations and similar locations.

ROOF MOUNTED CURBS AND EQUIPMENT SUPPORTS

Curbs and equipment supports for roof mounted equipment shall be of monolithic construction, not less than 18 ga. galvanized steel, with continuous welded corner seams, factory installed wood nailer, built-in raised cant of height as required for thickness of roof insulation, and base as required for attaching to the roof structure.

Curbs shall be internally insulated with 1½" thick, 3 lb. density rigid glass fiber board and shall have galvanized sheet metal liner. Equipment supports shall have integral base plate, wood nailer, and 18 gauge galvanized steel flashing cap.

Curbs and equipment supports shall be of size as required to properly mate with equipment to be mounted on the curbs or supports and shall be designed and constructed to safely support the weight of the equipment. The height of curbs shall be as indicated on drawings, but not less than 13½" high above the roof deck, unless called for or specified otherwise.

The curbs and supports shall be securely attached to the roof structure to withstand wind pressures on the vertical surface of the curb or supports and the mounted equipment by wind velocities up to 100 MPH. The complete installation shall be made watertight and shall be coordinated with the roofing installer.

Manufacturers:

Roof Curbs

Pate Manufacturing Company: PC-2
Thycurb
Custom Curb

Equipment Supports

Pate Manufacturing Company: ES-5A
Thycurb
Custom Curb

EXECUTION

METHOD OF INSTALLATION

Comply with MSS SP-69 and SP-89 for installation of hangers, supports and anchors. Install hangers, supports, clamps, and attachments directly from building structure complete with inserts, bolts, rods, nuts and washers, and washers, and accessories. Do not use wire or perforated metal to support piping; pipe support from other piping shall not be permitted. Install hangers with minimum ½" clear space between finished covering and adjacent work. Place hanger within 1 foot of each horizontal elbow. Use hangers vertically adjustable 1½" minimum after piping is erected.

Insulated pipe, hangers and supports shall be furnished with ribbed galvanized steel shields of not less than 18 gauge; two-piece pre-molded, high compressive strength, insulation inserts (360° around pipe); and vapor barrier jacket covering the insulation inserts. Inserts shall be constructed of high density, 100 psi, waterproofed calcium silicate, encased in 360° sheet metal shield. Provide assembly of same thickness as adjoining insulation.

Maximum spacing of hangers and supports shall be in accordance with the following schedule for size of pipe:

Pipe Size	Rod Size	Ferrous Pipe	Copper Pipe	Plastic Pipe
½" & ¾"	¼"	8'-0"	6'-0"	4'-0"
1" & 1¼"	3/8"	9'-0"	7'-0"	4'-6"
1½"	3/8"	9'-0"	8'-0"	5'-0"
2" & 2½"	3/8"	10'-0"	9'-0"	5'-0"
3" & 4"	5/8"	10'-0"	10'-0"	6'-0"
6" to 12"	7/8"	14'-0"	7'-0"	
14" to 18"	1"	20'-0"		

Hangers for cast iron pipe shall be installed on maximum 5'-0" centers.

Supports on masonry walls shall have bolts through wall fastened to suitable steel plate on back of wall. Where required to allow for movement of pipe by expansion due to short hanger rods, pipes shall rest on rollers and covering protection saddles. All piping shall be supported and secured as required to prevent vibration and the transmission of noise and lateral movement.

The Contractor shall furnish and install all necessary material, hangers and support including all structural steel members and shapes to substantially support and/or suspend all piping and equipment, in an approved manner. Perforated strap hangers will not be acceptable.

Drive screws, pins, studs, etc., which are secured in place by means of explosive force will not be permitted.

Except as specifically otherwise approved, no item of equipment shall support any pipe or duct nor shall any item of equipment be supported on any pipe or duct.

Hangers shall be provided at every item of equipment and at every change in direction or branch connection to every pipe.

All pipes through roof shall be installed with sleeves and openings, and with roof flashing/counterflash assembly or pipe curb assembly as herein specified. The complete installation shall be coordinated with the roofing installer and shall be watertight and weather tight.

Sleeves shall be steel pipe and shall be installed for single pipe installation. Openings shall be boxed out for multiple installations. Sleeves for acid waste vent stacks shall be installed as specified under the heading: Sleeves and Openings.

Single, un-insulated pipes through roof shall be installed with flashing/counterflashing assembly with four pound seamless lead flashing assembly with 8" high boot and not less than 8" skirt. A conical shaped steel reinforcing boot underneath lead flashing assembly shall also be installed. Cast iron counterflashing fitting with rust-resistant prime coat, of the caulking type to fit over all types of piping, vandal-proof set-screws for anchoring in place, and top annular space for sealant fill shall also be installed for single, un-insulated pipes. Assemblies shall be furnished in sizes to properly fit size of pipe with which they are installed. Flashing assembly shall be designed to fit properly on roofs from level up to 20° pitch. Top of flashing cone shall be sealed before installing counterflash fitting. Annular space in top of counterflash fitting shall be completely filled with epoxy sealing compound.

Grouped multiple pipes through roof and insulated pipes through roof shall be installed with factory prefabricated metal curb assembly of unitized construction of not less than 18 ga. galvanized steel with base plate for anchoring to roof deck or roof slab. The cant base for roof insulation thickness shall match the thickness of insulation where it is to be installed. A wood nailer strip shall be installed on top of the curb, and shall have 1½" thickness of 3 lb. density fiberglass insulation on inside, and not less than 11" high from base to top of wood nailer. The curb assembly shall also have an acrylic clad ABS plastic flashing cover with number and size of formed openings as required for the number and size pipes through roof, along with a graduated step neoprene boot for each pipe. A neoprene boot shall be secured around pipe and around formed opening in flashing cover with stainless steel clamps for waterproof connections. Insulation on insulated pipes shall be continuous through the curb, flashing cover, and the neoprene boot. After roofing is flashed up over the curb and secured in place, the ABS plastic flashing cover shall be installed over curb and flash roofing and anchored in place for a watertight and weather tight installation.

Furnish and set all boxouts for openings and all sleeves for work to be installed under this division. Sleeves shall be installed for all pipes passing through floors, walls, and partitions. All sleeves shall be set tight in construction, without space between the sleeve and construction. Sleeves through walls and partitions shall be flush at each end and sleeves through floor shall extend 2" above finished floor unless indicated otherwise.

Sleeves through concrete slabs, concrete walls, and bearing masonry walls shall be steel pipe of not less than Schedule 30. Sleeves through non-bearing wall and partitions may be Schedule 10 pipe or 22 ga. sheet steel with formed bead on each end.

The annular space around bare pipes and pipe insulation on insulated pipes through sleeves shall be packed tightly with mineral wool to prevent transmission of air and sound. Each end of sleeve at floors and through fire-rated walls shall also be sealed with 1" thickness of waterproof and fireproof caulk equivalent to 3M #CP25 fireproofing caulk.

Sleeves for round and rectangular ducts shall be galvanized steel. Sleeves through fire and smoke walls shall comply with NFPA 90A. Size sleeves to allow for expansion movement and to provide for continuous insulation.

Duct Hangers and Supports Installation

Provide and install duct hangers and supports as indicated on the following schedule:

Low velocity ducts hanger minimum sizes:

Up to 30" wide: 1¼" x 3/16" angle at 10 feet spacing
31" to 48" wide: 1½" x 3/16" angle at 10 feet spacing

Over 48" wide: 1½" x 3/16" angle at 8 feet spacing

Horizontal duct on wall supports minimum sizes:

Up to 18" wide: 1½" x 16 gauge or 1" x 1" x 1/8" at 8 feet spacing
19" to 40" wide: 1½" x 1½" x 1/8" at 4 feet spacing

Assemble and install ductwork in accordance with SMACNA standards, in a manner which will achieve air-tight and noiseless systems, capable of performing each indicated service. Align ductwork accurately at connections. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts straight, plumb and free of sags and vibration. Ducts shall be supported with steel rods of not less than 3/8" diameter or not less than 1" wide, 16 gauge galvanized steel straps.

Support ductwork from building structure where not otherwise indicated, anchor with bolts, concrete inserts, steel expansion anchors, welded studs, C-clamps, or special beam clamps. Supporting ductwork from piping, electrical equipment or cable trays will not be permitted.

Arrange hangers, supports and duct resets to permit free, unrestrained and noiseless expansion and contraction of duct. Vertical members may be fastened to duct sides with sheet metal screws. Seals all screw attachments to ductwork with mastic and seal gas tight.

Each Contractor shall provide all structural steel and materials necessary to properly support and anchor equipment and lines provided under this contract.

All equipment and materials shall be securely attached to the building structure in an approved manner. Attachments shall be of a strong and durable nature and suitable for the service required.

Concrete bases shall be provided where shown on the drawings. Equipment which is to be grouted in place shall be grouted with Embeco or approved non-shrink grout.

END OF SECTION 230529

SECTION 23 05 48 – MECHANICAL VIBRATION ISOLATION

GENERAL

DESCRIPTION OF WORK

Vibration Isolators

Pad Type Isolators

QUALITY ASSURANCE

All vibration isolation of rotating and reciprocating mechanical equipment and piping systems furnished under this contract, unless specified otherwise, shall be the complete responsibility of a vibration isolation manufacturer. All isolation equipment shall be of the same manufacturer and the selection of the proper isolators, including number and locations, shall be the responsibility of this manufacturer.

The isolation manufacturer shall determine the weight of equipment, distribution of weight and location as well as type and size of isolators required to provide uniform deflection. Manufacturer shall furnish all rails, steel framing members, isolators and all accessories necessary to provide complete installations. Due consideration shall be given to building resonance, floor spans, floor deflection and proximity of equipment to occupied areas when making isolator selections.

The isolation manufacturer shall coordinate his selections with the exact equipment that is actually to be furnished for installation and shall be completely responsible for satisfactory vibration and noise control throughout the installation.

The isolation manufacturer shall provide adequate installation information without delay to insure that proper provisions are made for the installation of isolators and avoid conflicts during construction.

SUBMITTALS

Submit in accordance with General Requirements, Division 1, Section 013300.

Submittals required:

Furnish shop drawings to include manufacturer's model number for each isolator to be furnished, number and location of isolators to be furnished for each machine or pipeline, free height, deflected height, and loading for neoprene or fiberglass isolators, and dimensional and weight data for steel rail bases together with method of attachment of isolators to bases.

Vibration isolation shop drawings shall show isolator locations, load on each isolator, and shall also include installation instructions.

PRODUCTS

VIBRATION ISOLATORS

Material

All spring type isolators shall be capable of 30 percent over travel before becoming solid.

Centrifugal exhaust fans located on the roof shall be installed with free standing spring type housed isolators with not less than 1/4" thick neoprene acoustical friction pads on the bottom of the isolators.

Manufacturer

Consolidated Kinetics Corp.

Korfund Dynamics Corp.

Mason Industries, Inc.

Pad Type Isolators

General: Provide pad type isolators in thicknesses and shapes required for use in vibration isolation units.

Neoprene Pads: Oil-resistant neoprene, standard hardness, cross-ribbed or waffled pattern.

EXECUTION

METHOD OF INSTALLATION

Comply with manufacturer's instructions for installation and load application to vibration isolation materials and units.

Adjust to ensure that units do not exceed rated operating deflections or bottom out under loading, and are not short-circuited by other contacts or bearing points. Remove space blocks and similar devices intended for any temporary protection against overloading during installation. Anchor and attach units to substrata and equipment as required for secure operation and to prevent displacement by normal forces. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units where leveling devices cannot be used to distribute loading properly.

Isolation requirements:

Isolation shall be stable during starting and stopping of equipment without any transverse and eccentric movement of equipment that would damage or adversely affect the equipment or attachments.

The installed vibration isolation system for each floor or ceiling mounted item of equipment shall have a maximum lateral motion under equipment start up and shut down conditions of 1/4". Motions in excess shall be restrained by approved spring type mountings.

All electrical connections, drain connections, piping connections, etc. made to equipment which rests on vibration isolators, shall be sufficiently flexible to permit the equipment to be properly isolated. Care shall be taken so that the equipment isolation is not "short-circuited" by connection to the equipment or attachments to the equipment.

Isolation shall be selected for the lowest operating speed of equipment.

Isolators, including springs, exposed to weather shall be hot dipped galvanized after fabrication. The hot dipped zinc coating shall be not less than two ounce per square foot by weight complying with ASTM A-123.

Isolators shall be selected and located to produce uniform loading and deflection even when equipment weight is not evenly distributed. Special foundation suspension systems shall be furnished for equipment having a large unbalance in the horizontal direction. Isolators for special bases shall have equipment manufacturer's approval.

Isolators for equipment mounted on roof or other outdoor installations shall be furnished with vertical stops as required to limit displacement caused by wind conditions.

Where ducts pass through mechanical equipment room or fan room walls, the space around the duct shall be sealed tight to prevent transmission of noise from the equipment or fan room to spaces outside these rooms.

Piping: For piping connected to equipment mounted on vibration control products, install isolation hangers as specified in specification section "Hangers and Supports".

Performance Of Isolators

General: Provide vibration isolators as indicated below:

Air Handling Units		*Neoprene Pads*
Vane Axial or In-line Exhaust Fans	*Housed*	*Spring Hanger Isolators*
Centrifugal Exhaust Fans		*Free Standing Spring Isolators*
Pumps		*Neoprene Pads*

END OF SECTION 230548

SECTION 23 05 53 – MECHANICAL IDENTIFICATION

GENERAL

DESCRIPTION OF WORK

Mechanical Identification for:

Mechanical Identification Materials
Pipe Labels

SUBMITTALS

Submit shop drawings in accordance with General Requirements, Division 1.

Submit copies valve schedule for each piping system, typewritten and reproduced on bond paper. Tabulate valve number, piping system, system abbreviation, location of valve and variations for identification. Mark valves which are intended for emergency shut-off and similar special uses, by special "flag", in margin of schedule. Include valve schedules within Maintenance Manuals (Re: 230500) and Division 1.

PRODUCTS

MECHANICAL IDENTIFICATION MATERIALS

Stencils: Fiberboard: ANSI A13.1 letter sizes for ductwork; minimum 1-1/4" high letters for ductwork and minimum 3/4" high letters for access door signs and similar operational instructions. Stencil paint: Exterior type black.

Valve tags: 19 gauge polished brass, 1-1/4" diameter, stamp engraved black enamel fitted. Valve tag fastener shall be solid brass chain.

At Contractors option, valve tags may be 3/32" thick engraved plastic laminated valve tags, within piping system abbreviation in ¼" high letters and sequenced valve numbers ½" high letters, and with 5/32" hole for fastener. Valve tag shall be white with black lettering.

Valve schedule frames: For each page of valve schedule, provide glazed display frame with screws for removable mounting on masonry walls. Frame shall be extruded aluminum with SSB-grade sheet glass.

Plastic Labels for Equipment:

Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
Letter Color: White.
Background Color: Black.
Maximum Temperature: Able to withstand temperatures up to 160° F.

Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

Fasteners: Stainless-steel rivets.

Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

PIPE LABELS

General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.

Lettering Size: At least 3/4 inches high.

EXECUTION

PREPARATION

Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

DUCTWORK IDENTIFICATION

Identify air supply, return, exhaust, intake and relief ductwork with stenciled signs and arrows, showing ductwork service and direction of flow. Locate identification in each space where ductwork is exposed, or concealed only by removable ceiling system and near points where ductwork originates or continues into concealed enclosures, (shaft, underground or similar concealment) and at 50 foot spacing along exposed runs.

Access doors shall have stenciled type signs on each access door in ductwork and housings. Indicate purpose of access (to what equipment); and other maintenance and operating instructions, and appropriate safety and procedural information.

PIPE LABEL INSTALLATION

Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

Near each valve and control device.

Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

Near penetrations through walls, floors, ceilings, and inaccessible enclosures.

At access doors, manholes, and similar access points that permit view of concealed piping.

Near major equipment items and other points of origination and termination.

Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

On piping above removable acoustical ceilings. Omit intermediately spaced labels.

Pipe Label Color Schedule shall be per the following table:

Pipe System	Legend	Letter Color	Background Color
Steam 120 PSIG	S120	Black	Yellow
Steam 60 PSIG	S60	Black	Yellow
Steam 15 PSIG	S15	Black	Yellow
Heating Hot Water Supply	HHWS	Black	Yellow
Heating Hot Water Return	HHWR	Black	Yellow
Chilled Water Supply	CHWS	White	Green
Chilled Water Return	CHWR	White	Green
Cooling Tower Water Supply (From Tower)	CTS	White	Green
Cooling Tower Water Return (To Tower)	CTR	White	Green
Thermal Storage Water	TSW	Black	Yellow
Humidification Steam	HS	Black	Yellow
Pure Steam	PS	Black	Yellow
Steam Condensate Return	COND	Black	Yellow
Refrigerant Liquid Piping	RL	Black	Yellow
Refrigerant Suction Piping	RS	Black	Yellow

VALVE IDENTIFICATION INSTALLATION

Valve tag location: Provide valve tag on all valves, cocks, and control devices in each piping system. List each tagged valve in valve schedule for each piping system. Mount valve schedule frames and schedules in machine room where directed by Owner's Representative.

MECHANICAL EQUIPMENT IDENTIFICATION

Install engraved plastic laminate signs except where lettering larger than 1" is required for proper identification. Locate signs in or near each piece of mechanical equipment and each operation device.

Provide plastic laminated signs at main control and operating valves, fans, pumps, meters, gauges, thermometers, thermostats, VAV boxes, fan terminal units, duct mounted coils, control devices, sensors, fans and primary balancing dampers.

Laminated tags, at a minimum, shall be provided for each piece of equipment scheduled on drawings.

All temperature sensors, differential pressure switches, and control devices integrated with the building control systems shall be permanently marked to indicate normal operating points or range for both summer and winter operation. Coordinate with Engineer and Owner prior to marking. In addition, all room sensors shall have laminated tags mounted adjacent to the room sensor on wall or within the cover of the sensor itself. The laminated tag shall indicate the device which the sensor serves; (RC-1, VAV-1 etc.).

WARNING AND DANGER SIGNS

Where identifications signs are required to indicate a warning or danger, signs shall be plastic laminated with red background and white lettering. At a minimum warning signs shall be provided as follows:

All air handling unit access doors to fans and access doors downstream of fan discharge and elsewhere as required, to indicate an unsafe condition.

All motor driven equipment that automatically starts shall include a warning sign indicating such. Coordinate wording of danger sign with facility manager.

END OF SECTION 230553

SECTION 23 05 93 – MECHANICAL TESTING, ADJUSTING AND BALANCING

GENERAL

DESCRIPTION OF WORK

Air balancing of air handling systems.

Hydronic balancing of air handling systems including chilled water coils, heating hot water coils, variable air volume terminal units, exhaust fans, etc.

Air balancing of each diffuser, grille and register at air volume indicated on the drawings.

Full system balancing and validation of VAV terminal units.

Fully system balancing and validation of any exhaust system.

Start-up of services for air handling units (associated VAV boxes) and electronic control systems.

Validation assistance of control systems with Commissioning Agent (if required).

QUALITY ASSURANCE

Testing, balancing and start-up services shall be done by an Independent Contractor. The Independent Contractor shall have a proven record of doing TAB work for a period of at least 3 years. At the Owners request, references may be requested from the Contractor to verify past performance.

Submit evidence that personnel who perform testing and balancing of project systems are qualified personnel; for review and approval by Owner prior to performing work.

Submit list of completed projects successfully tested and balanced by submitted, qualified personnel for review and approval by Owner prior to performing work.

Perform all corrective measures caused by faulty installation; re-test, re-adjust and re-balance systems until satisfactory results are achieved.

Qualified personnel are:

Personnel certified by one of the following organizations:

AABC - Associated Air Balance Council
Certified TBAB - Certified Testing, Balancing and Adjusting Bureau
NEBB - National Environmental Balancing Bureau
TABIC - Test & Balancing Institute for Certification

Personnel Registered as a Professional Engineer.

SUBMITTALS

Preliminary:

Submit three copies of documentation to confirm compliance with Quality Assurance provisions:

Organization supervisor and personnel training and qualifications
Specimen copy of each of report forms proposed for use

Second: At least fifteen days prior to starting field work submit three copies of the following:

Set of report forms filled out indicating design flow values and required CFM for all diffusers.

Complete list of instruments proposed to be used, organized in appropriate categories, with data sheets for each instrument. Furnish the following information:

Manufacturer and model number
Description and use when needed to further identify instrument
Size or capacity range
Latest calibration date

Engineer will review submittals for compliance with Contract Documents and return one set marked to indicate the following:

Discrepancies noted between data shown and Contract Documents
Additional or more accurate instruments required
Requests for re-calibration of specific instruments

Third: At least fifteen days prior to Contractor's request for final inspection, submit three copies of final reports on applicable reporting forms for review.

Schedule testing and balancing of parts of systems delayed due to seasonal, climatic, occupancy or other conditions beyond control of Contractor as early as proper conditions will allow, after consultation with Engineer.

Submit reports of delayed testing promptly after execution of those services.

Form of Final Reports:

Each individual final reporting form must bear signature of person who recorded data and TAB supervisor of reporting organization.
When more than one certified organization performs TAB services, the firm having managerial responsibility shall make the submittals.

PRODUCTS

Not Used.

EXECUTION

START-UP SERVICES

Prior to beginning Testing, Adjusting and Balancing (TAB) work the Independent TAB Contractor shall perform all start-up services as follows:

Inspect all bearings for cleanliness and alignment. Bearings which are found to be defective shall be noted as such to the Owner for replacement by the installing Contractor. Grease as necessary all bearings in accordance with the manufacturer's instructions.

Adjust tension for all drives and adjust variable pitch drives to the RPM scheduled or noted on shop drawings.

Check each motor for amperage comparison to nameplate value. Motors which produce excessive current flow shall be noted as such to the Owner so corrections can be made by the installing Contractor.

Check electrical control circuits to insure that operation complies with the Specifications.

Inspect each pressure gage and thermometer for calibration.

HYDRONIC BALANCING

Make measurements in accordance with recognized procedures and practices of certifying association. Water flows shall be balanced to within ± 5 percent of design requirements.

Check conditions at cooling and heating coils for required performance at design conditions.

Mark all balancing devices as specified.

AIR BALANCING

Make measurements in accordance with recognized procedures and practices of certifying association. Measure air volume discharged at each outlet and adjust air outlet to design air volumes within ± 5 percent. Adjustments made for building envelope to maintain pressure relationship specified hereinbefore shall be coordinated with the Owner.

Adjust fan speeds and motor drives within drive limitations for required air volume. Set speed to provide air volume at farthest distance without excess static pressure.

Mark all balancing dampers and cocks.

Upon completion of renovation, Test & Balance contractor shall be responsible for “hard-balancing” all other spaces served by air handling units. Test and balance contractor shall obtain existing airflow readings/results from owner for purposes of completely rebalancing system.

COORDINATION

Coordinate services with work of various trades to insure rapid completion of services.

Promptly report to Engineer any deficiencies noted during performance of services to allow immediate corrective actions to be performed.

END OF SECTION 230593

SECTION 23 07 13 – MECHANICAL DUCT INSULATION

gENERAL

DESCRIPTION OF WORK

Duct Insulation

RELATED DOCUMENTS

American Society for Testing and Materials

Flame Spread: 25 or less; ASTM E84, NFPA 255

Smoke Developed: 50 or less; ASTM E84, NFPA 255

National Fire Protection Association, NFPA:

Composite ductwork lining installation including lining, sealers, mastics and adhesives, NFPA 255 method with Flame spread rating 25 or less and Smoke developed rating: 50 or less. NFPA No. 90A and 90B

QUALITY ASSURANCE

Insulation shall not be applied until all ductwork has been tested and approved and thoroughly cleaned. All insulation work shall present a neat appearance with smooth and uniform surfaces. Work done in a slovenly manner will not be acceptable. All insulation joints shall be carefully fitted and tightly butted. All jacket materials shall be neatly applied with smooth surfaces and shall be securely adhered or pasted in place. All seams and joints shall be located so that they are as inconspicuous as possible. Exposed edges and ends of all insulation shall be sealed and finished to provide a complete, unbroken vapor seal. The Contractor shall install insulation to be continuous through pipe sleeves.

Failure, due to faulty workmanship or material, of any portion of the installed insulation to perform the function as intended by these specifications, either stated or implied, for a period of one (1) year after acceptance of the project by the Owner, shall be the responsibility of the Contractor and shall be rectified at no additional cost to the Owner. This shall include the loosening of any jacket material, the appearance of condensation on the outside of the insulation, or any other mechanical or thermal failure which affects either appearance or efficiency of installation.

SUBMITTALS

Submit shop drawings for all insulating materials in accordance with Division 1.

Shop Drawings:

Submit shop drawings which indicate complete material data, mastics, adhesives, list of materials proposed for this project and indicate thickness of material for individual services.

Product Data:

Provide current manufacturer's data to show compliance with these specifications and governing regulations; include proof of compliance for test products of products for fire and smoke rating, corrosiveness and compressive strength.

EQUIPMENT

DUCT INSULATION

Material - Insulate all new supply air and outdoor air intake ducts, outdoor air intake ducts, ductwork exposed to outdoor weather, ducts located where the ambient temperature is greater than the temperature of the air within the duct system and at all locations where condensing on ductwork is possible unless noted otherwise with 1½" thick flexible glass fiber blanket, approximately 1 lb/cu ft density, with a K value of 0.26 at 75° F. The insulation shall be suitable for temperatures up to 250° F. Furnish and install insulating jacket, Factory-applied foil-scrim-kraft vapor barrier.

Manufacturer:

Certain-Teed Corp: Standard Duct Wrap Type IV
Knauf: Duct Wrap-FSK
Manville Corp.: R Series Microlite-FSKL
Owens-Corning: Faced Duct Wrap-FRK 25-

All supply ducts to receive 1.5" wrap, all exhaust ducts to be exposed.

EXECUTION

METHOD OF INSTALLATION

Duct Insulation:

Systems shall be completely covered throughout, including fittings and accessories. All fittings and accessories shall be accessible for maintenance. Unless specified otherwise, insulation shall extend continuous through sleeves.

All adhesives, tape and any other material used for sealing shall be applied in strict accordance with manufacturer's instructions which includes covering rate of application, method of application, temperature limits for application of said materials, or any other condition affecting efficiency or permanence of the installation.

All external surface of ductwork shall be wiped clean before installation of insulation. Insulation shall be wrapped on exterior of ductwork with all joints butted and all longitudinal seams overlapped not less than 2". Insulation shall be adhered to metal ductwork with not less than 4" strips of insulation adhesive, applied to ductwork at not greater than 8" O.C. On ducts wider than 18", the insulation on bottom of ductwork shall be additionally secured with welding pins secured to ductwork at not greater than 18" O.C. All joints, all longitudinal seams, all welding pins, and all penetrations shall be applied so that compressed thickness at corners of ductwork is not less than 1". Seal joints and breaks (in ducts conveying air at less than room temperature) with 4" wide strips of open mesh glass cloth or tape imbedded between 2 coats of vapor barrier sealant. Point up other joints and breaks with hydraulic setting cement.

The completed installation shall form a smooth and neat appearance.

EXISTING INSULATION

Repair insulation damaged or disturbed during construction with approved, similar materials, installed to match existing. Install new jacket lapping and sealed over existing.

ACCESSORIES

Provide staples, bands, wire, wire netting, tape corner angles, anchors, stud pins and metal covers recommended by insulation manufacturer for application indicated. Do not use staples on cold water insulation. Provide adhesives, cements, sealers, mastics and protective finishes recommended by insulation manufacturer for application indicated.

outdoor protection

All outdoor insulation shall be covered with a weather protective jacket consisting of 22 gage aluminum or 26 gage stainless steel protective covering. Edges of exterior jacket shall be securely closed around insulation to prevent rain, snow, dirt, etc. from damaging the underlying insulation in any fashion.

END OF SECTION 230713

SECTION 23 07 19 – MECHANICAL PIPING INSULATION

gENERAL

DESCRIPTION OF WORK

Piping Insulation (Glass Fiber Type)

Piping Insulation (Flexible Foam Plastic Type), condensate drains only

PVC Jacketing

RELATED DOCUMENTS

American Society for Testing and Materials

Flame Spread: 25 or less; ASTM E84, NFPA 255
Smoke Developed: 50 or less; ASTM E84, NFPA 255

QUALITY ASSURANCE

Insulation shall not be applied until all piping has been tested and approved and thoroughly cleaned. All insulation work shall present a neat appearance with smooth and uniform surfaces. Work done in a slovenly manner will not be acceptable. All insulation joints shall be carefully fitted and tightly butted. All jacket materials shall be neatly applied with smooth surfaces and shall be securely adhered or pasted in place. All seams and joints shall be located so that they are as inconspicuous as possible. Exposed edges and ends of all insulation shall be sealed and finished to provide a complete, unbroken vapor seal. The Contractor shall install insulation to be continuous through pipe sleeves.

Failure, due to faulty workmanship or material, of any portion of the installed insulation to perform the function as intended by these specifications, either stated or implied, for a period of one (1) year after acceptance of the project by the Owner, shall be the responsibility of the Contractor and shall be rectified at no additional cost to the Owner. This shall include the loosening of any jacket material, the appearance of condensation on the outside of the insulation, or any other mechanical or thermal failure which affects either appearance or efficiency of installation.

SUBMITTALS

Submit shop drawings for all insulating materials in accordance with Division 1, Section 013300.

Shop Drawings:

Submit shop drawings which indicate complete material data, mastics, adhesives, list of materials proposed for this project and indicate thickness of material for individual services.

Product Data:

Provide current manufacturer's data to show compliance with these specifications and governing regulations; include proof of compliance for test products of products for fire and smoke rating, corrosiveness and compressive strength.

EQUIPMENT

PIPE INSULATION (GLASS FIBER TYPE)

Material – Pipe insulation including fittings and devices, unless specified otherwise, shall be insulated with 1-piece rigid molded glass fiber, 4 lbs/cu ft density with a K value of 0.22 at 75°F. The insulation shall be suitable for temperatures of –40° to 450°F, and with longitudinal flap, butt joint end strips and factory applied pressure sealing lap adhesive.

Manufacturers:

Insulation:

Certain-Teed: CSG Snap-On ASJ-SSL Products
Knauf: Pipe Insulation
Manville Corp.: J-M Micro-Lok, 650 APT
Owens-Corning: One-Piece Fiberglass 25

Fitting Covers:

Certain-Teed: Snap-On Products
Insul-Coustic: Insul-Sure Heavy Density Birma
Manville Corp.: Zeston, One Piece Pre-molded PVC Cover with Fiberglass Insert.

PIPE INSULATION (FLEXIBLE FOAMED PLASTIC TYPE)

Material - Flexible foamed plastic insulation shall be vapor sealed pipe covering.

Manufacturer:

Armstrong: "Armaflex II".
Certain-teed
Rubatex Corp.

PVC JACKETING

Provide PVC Jacketing on all pipe insulation located below the ceiling line in non-mechanical spaces. Areas include all manufacturing and process areas. Cover pipe fittings and other equipment from an outside diameter of 1-5/8" to 24" in accordance with ASTM C-585.

PVC jacketing material shall be gloss white outdoor and spray down weatherable. Fittings, unique shapes fit screwed, welded and flanged elbows, tees, valves, couplings, laterals, reducers and end caps. The Jacketing shall be.020" minimum thicknesses. The Jacketing and Fitting Covering Systems include solvent weld adhesives, stainless steel tack fasteners, silicone caulking and adhesive tapes. A die-cut multi-temperature fiberglass insulation insert is available and sized for a full insulation over the exposed pipe fitting and under the overlay of the PVC Fitting Cover.

Code Compliance: PVC Fitting Covers and Jacketing meet: Military Specification LP-1035A, Type 11 Grade GU and Type 111, and LP-535E, Type 11 Grade GU and Type 111. Federal Specification HH-I-558, Form B, Type 1 Class B. Requirements of USDA and FDA for use in facilities of the food processing, beverage and pharmaceutical industries. PVC jacketing 25/50 fire class per ASTM E-84. Thermal conductivity of 0.26 BTU/hr/sq ft/°F/In

The system shall have an applicable temperature range of -35°F to 500°F (-37°C to 260°C).

EXECUTION

METHOD OF INSTALLATION

Systems shall be completely covered throughout, including valves, fittings and accessories. Strainer covers and valve bonnets shall be accessible for maintenance. Unless specified otherwise, insulation shall extend continuous through sleeves. Where pipe covering terminates at ceilings, wall and equipment, furnish and install covering protector cups fastened to covering. Cups shall be Zeston polyvinyl chloride (PVC), or approved equal.

All adhesives, tape and any other material used for sealing shall be applied in strict accordance with manufacturer's instructions which includes covering rate of application, method of application, temperature limits for application of said materials, or any other condition affecting efficiency or permanence of the installation.

Where pipe hangers are present, insulated pipe shall be furnished with ribbed galvanized steel shields of not less than 18 gauge, two-piece pre-molded, high compressive strength, insulation inserts (360° around pipe), and vapor barrier jacket covering the insulation inserts. Inserts shall be constructed of high density, 100 psi, waterproofed calcium silicate, encased in 360° sheet metal shield. Provide assembly of same thickness as adjoining insulation.

Service access shall be provided through insulation where required. Insulation at flanged joints shall be designed to permit removal of flange bolts and nuts. Insulation for removable flanges of cold pipe strainers shall be fabricated with built-up sections of fiberglass pipe covering arranged to facilitate servicing of the strainer. Applications shall be complete with vapor seals.

PIPE INSULATION (GLASS FIBER)

Installation shall be in strict accordance with the manufacturer's instructions. Jacket shall have finish so as not to require field painting, but shall be suitable for field painting if desired.

Fittings, valves and accessories shall be insulated with PVC fitting covers with glass fiber inserts to provide same insulating values as the pipe insulation in locations where piping is exposed to view. Strainer covers and valve bonnets shall be accessible for maintenance. Fitting covers on "cold" pipe requiring vapor barrier jackets shall be installed vapor tight using adhesive and "Z"-tape applied to the circumferential joints, overlapping the fitting cover and adjacent insulation jacket. No tacks shall be used on vapor tight fitting covers.

Where piping is concealed by construction, the fittings, valves, and accessories shall be insulated with PVC covers as specified for exposed piping. Strainer covers and valve bonnets shall be accessible for maintenance.

Use of staples is prohibited, except staples may be used in the longitudinal joints. If after staples are installed, the entire longitudinal joint shall be covered with 3" wide adhesive backed strip to match insulation jacketing to cover staples and securely attached.

Piping to be insulated and thickness of insulation shall be as follows:

Piping Insulation Thickness

Piping System	Pipe Sizes	Thickness
Refrigerant Suction/Liquid Piping (outdoor piping with aluminum jacket)	Thru 1½" Thru 1.5” 2” and Larger	1” 1" 1½"

PIPE INSULATION (FLEXIBLE FOAMED PLASTIC)

Insulation shall be slipped on piping prior to installation as much as practical. Where this is not possible, insulation shall be carefully split, applied over pipe and sealed with approved vapor barrier mastic. Fittings, valves, and accessories shall be covered with cut and mitered sections of required size. Strainer covers and valve bonnets shall be accessible for maintenance. All joints shall be carefully made and completely sealed to maintain the integrity of the installation. Joints or seals improperly made will be rejected and they shall be repaired without additional cost to the Owner.

Where insulated pipes pass through floor, ceilings, and walls, and are exposed to view (not concealed by construction), the Contractor shall furnish and install cover (escutcheon) plates

Piping Insulation Thickness

Piping System	Pipe Sizes	Thickness
Condensate Piping	All sizes	1"
Coil Drains	All Sizes	1"

ACCESSORIES

Provide staples, bands, wire, wire netting, tape corner angles, anchors, stud pins and metal covers recommended by insulation manufacturer for application indicated. Do not use staples on cold water insulation. Provide adhesives, cements, sealers, mastics and protective finishes recommended by insulation manufacturer for application indicated.

outdoor protection

All outdoor insulation shall be covered with a weather protective jacket consisting of 22 gage aluminum or 26 gage stainless steel protective covering. Edges of exterior jacket shall be securely closed around insulation to prevent rain, snow, dirt, etc. from damaging the underlying insulation in any fashion.

END OF SECTION 230719

SECTION 23 09 23 – DIRECT DIGITAL CONTROL SYSTEM FOR HVAC

GENERAL

WORK INCLUDES

Complete system of automatic controls

Installation and interface with building automation system

Control devices, components, wiring, and materials

Assist in system validation of control systems, including device calibration, software validation and system wiring

Instructions to Owner

The DDC shall be limited to Diakin, Trane, Siemens, Automated Logic, Honeywell, or by substitution request. All control components such as sensors, DDC controllers, panels, etc… shall be provided by and installed by the Mechanical & Electrical contractors. The system shall be Bacnet MSTP or IP

It is the intent of these specifications to provide a complete operating and control system manufactured by THE SAME single manufacturer and installed by the same single supplier. Installation shall be turnkey and include additions/modifications to the existing DDC control system, all conduit and wiring, any BAS interfacing, any lighting or fire alarm networking, and start-up/commissioning services.

The generic scope is for VRF system, Boiler Plant, radiant floor system, hanger ventilation/makeup air, temperature sensors, network backbone work, single control panel. Include software and graphics installed on one TMA CPU as determined by owner.

SUBMITTALS

Control submittals for this project WILL NOT be compromised. The engineer will continue rejecting shop drawings that do not meet the requirements of this section until the submittal meets every requirement as specified. Please do not waste your time our ours submitting anything that has not been approved including sensors, controllers, actuators and other devices. Items submitted that do not meet the specifications will cause the entire shop drawing to be rejected without further review

Submit in accordance with General Requirements, Division 1, Section 01300. All drawings created for the control system submittal shall be created using 2024 REVIT or AUTOCAD Release 2023 or greater. All drawings shall be drawn to "D" size (30"x42"). Once all submittals have been approved the Contractor shall submit one electronic copy to A/E.

The submittal data shall also include the manufacturer's technical specifications and descriptive data for all equipment, hardware, peripherals, accessories, firmware, and software proposed to be provided under the contract. Any exception taken to any part of the system as specified and/or as indicated on the drawings and any alternatives to that specified and/or indicated on the drawings shall be clearly noted and outlined in the technical proposal submitted. Each manufacturer shall also submit with his bid proposal a check-off list as included under the Bid Proposal Instructions included in the Project Manual.

Before proceeding with installation of controls and devices, the Contractor shall submit complete shop drawings and descriptive data. Shop drawings shall be submitted as a 3-step process as specified hereinafter.

Direct Digital Control System Hardware

1. *Complete bill of materials indicating quantity, manufacturer, model number, and relevant technical data of equipment to be used.*

Manufacturer's description and technical data such as performance curves, product specifications, and installation and maintenance instructions for items listed below and for relevant items not listed below:

Direct digital controllers (controller panels)

Transducers and transmitters
Sensors (include accuracy data)
Actuators
Valves
Relays and switches
Control panels
Power supplies
Batteries
Operator interface equipment
Wiring

Schematic control drawings giving specific data on all settings, ranges, action, adjustments and normal positions for each control device.

Communications network schematic (LAN) indicating all user I/O devices and locations. Schematic shall include location of all DDC panels, Controllers and Third-party devices provided by equipment manufacturers.

Wiring ladder diagrams detailed adequately for field construction, including all related wiring. Ladder diagrams shall indicate terminal strip numbers, wiring logic for all control devices, safety interlocks and motor control interface.

Control valve schedule with complete sizing data for each valve giving required design flow and temperature, pressure, spring range for pneumatic actuators and other pertinent data.

Sequence of operation for each system corresponding to control schematics and these specifications.

Damper operator schedule, listing quantity, size of operators and mounting arrangement. For each pneumatic damper actuator indicate spring range.

For each physical point provide a document (spreadsheet) which, at a minimum, shall indicate the following:

User point identification name.
Logical point name.
Alarmable (yes or no).
Point description.
Point loop identification (P&ID)
DDC panel ID.
Fail position (open or closed).
Digital or Analog.
Latched point (Y or N) and Delay if latched point.
Analog range of device if applicable
Analog occupied set point.
Analog occupied high limit alarm.
Analog occupied low limit alarm.
Analog unoccupied set point.

For each virtual point provide a document (spreadsheet) which, at a minimum, shall indicate the following:

User point identification name.
Logical point name.
Control range if applicable
Point function and use.

Wiring diagrams and layouts for each control panel. Show termination numbers.

Floor plan schematic diagrams indicating field sensor and controller locations.

Riser diagrams showing control network layout, communication protocol, and wire types.

Central System Hardware and Software

Central Processing Unit (CPU) or web server
Monitors
Keyboards
Power supplies
Battery backups
Interface equipment between CPU or server and control panels
Operating System software
Operator interface software
Color graphic software
Third-party software

Instrumentation list (Bill of Materials) for each controlled system. List each control system element in a table. Show element name, type of device, manufacturer, model number, and product data sheet number.

Complete description of control system operation including sequences of operation. Include and reference schematic diagram of controlled system.

Training Materials: Provide course outline and materials for each class at least six weeks before first class. Training shall be furnished via instructor-led sessions, computer-based training, or web-based training. Engineer will modify course outlines and materials if necessary to meet Owner's needs. Engineer will review and approve course outlines and materials at least three weeks before first class.

Near the completion of the project the Contractor shall submit a complete control system operating and maintenance manual. O&M manual shall be assembled as specified in architectural specifications “submittals” Manual, at a minimum, shall include the following:

Include in O&M manual a control sequence for each control system specified within and shown on drawings.
Include a control system schematic for each control systems and its corresponding flow diagram (flow chart). Control schematics shall indicate complete control logic with all electric / pneumatic interlocks shown.
Commissioning and validate data including trends, PID settings, point configuration data and all other pertinent information needed to maintain the system

Include DDC point data information and complete software listing within O&M manual for each DDC panel.

As-built versions of submittal product data.

Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.

Operator's manual with procedures for operating control systems: logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.

Programming manual or set of manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.

Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.

Documentation of programs created using custom programming language including setpoints, tuning parameters, and object database. Electronic copies of programs shall meet this requirement if control logic, setpoints, tuning parameters, and objects can be viewed using furnished programming tools.

Graphic files, programs, and database on magnetic or optical media.

List of recommended spare parts with part numbers and suppliers.

Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.

Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation or web server software, and graphics software.

Licenses, guarantees, and warranty documents for equipment and systems.

Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.

CONTRACTOR QUALIFICATIONS

The Contractor shall have an office that is staffed with engineers trained in Integrating Interoperable Systems and technicians fully capable of providing BACnet instruction and routine emergency maintenance service on all system components.

Contractor shall have in house capabilities to provide control strategies for building control.

Contractor shall be a company willing and able to supply product from a variety of manufacturers. Companies owned by product manufacturers will be considered only if they submit a letter of intent with their bid stating their intention to provide an open BACnet system as defined herein that is comprised of products from multiple vendors.

Integrators listed to furnish and install the control work as specified herein shall be required to meet the full intent of these specifications. Listing the manufacturers name does not relieve the supplier from meeting the full intent of the specifications and therefore remains subjected to rejection by the Engineer during shop drawing review.

Siemens only

PRODUCT

GENERAL

Furnish and install temperature control systems for control of heating, cooling, ventilating, and exhaust systems with sensors, controllers, relays, switches, local control cabinets all required accessories, all control wiring required for temperature control systems, as called for by drawings and specifications and as required for a complete operable control system.

All control wiring for control system shall be provided and installed in accordance with the requirements specified under Division 26.

Control systems shall be complete and effective in the highest degree and shall comprise all parts and mechanisms necessary for their successful operation. Systems shall be free from defects in workmanship and material and shall be guaranteed to operate as required to maintain specified conditions and functions.

Any repairs, adjustments or replacements made necessary by such defects during the first full year from the time of acceptance of the project by the Owner shall be made by the Contractor and control manufacturer without charge to the Owner.

In general this project consists of a new HVAC control systems for the installation of a Building Automation System (BAS).

General: The control system shall consist of a high-speed, peer-to-peer network of DDC controllers and a web-based operator interface using the BACnet protocol.

Depict each mechanical system and building floor plan by a point-and-click graphic. A web server with a network interface card shall gather data from this system and generate web pages accessible through a conventional web browser on each PC connected to the network.

Operators shall be able to perform all normal operator functions through the web browser interface.

The system shall directly control HVAC equipment as specified hereinafter. Each zone controller shall provide occupied and unoccupied modes of operation by individual zone. Furnish energy conservation features such as optimal start and stop, night setback, request-based logic, and demand level adjustment of setpoints.

Provide for future system expansion to include monitoring of occupant card access, fire alarm, and lighting control systems.

System shall use the BACnet protocol for communication to the operator workstation or web server and for communication between control modules. Schedules, setpoints, trends, and alarms specified in Division 23 (Sequences of Operation) shall be BACnet objects.

Building Automation System (BAS) design indicates the minimum requirements for the control of equipment. Where additional wiring and controls devices are necessary to meet the intent of the control sequences these devices shall be provided regardless if shown on drawings.

Comply with BACnet Guidelines for all products. Utilize published functional profiles for all product network message and configuration parameters.

Network design shall provide high-speed data transfer rates for alarm reporting, quick report generation from multiple nodes (controllers), and up and down load efficiency between network devices.

Employ network error detection, and re-transmission to guarantee data integrity.

SYSTEM VALIDATION

Before each DDC panel is allowed to come on-line the system shall fully tested and commissioned and validated. The Contractor shall assist the Owner and his Engineer in completing the validation of the control systems installed under this project. Validation services shall include the following:

Point-to-Point verification of all wiring and tubing within the new control system. Provide qualified technicians to assist the Owner's Engineer in verifying correct installation of all wiring and pneumatic tubing in the system.

Software Verification: Provide qualified technicians and all necessary testing software to complete a through step-by-step walk through, verification and challenge to all system software, including alarms, loop tuning, set point adjustments and control sequences.

Component Calibration: Provide qualified technicians and calibration equipment to field calibrate 100% of control components installed under this contract. Each control device shall be calibrated in accordance with the manufacturers written instructions and procedures. All Component calibration shall be documented on standard calibration reporting forms provided to the Contractor for that purpose.

All PID control loops shall be tuned using Closed Loop or Open Loop method.

All controls and controlled items shall be placed in complete and proper operating condition subject to approval of the Engineer.

Once Owner and Engineer has accepted system the Contractor shall note all field modifications and settings on approved shop drawings and submit to the Engineer for approval. Changes to system operation, set points programming source code and loop parameters once accepted by Owner shall not be permitted unless prior approval has been given by the Engineer or the Owner.

a. All changes shall be documented with the date of the change and type of change, reason for change and complete description of change including point names, software code and other pertinent data.

System Performance

Performance Standards. System shall conform to the following minimum standards over network connections. Systems shall be tested using manufacturer's recommended hardware and software for operator workstation (server and browser for web-based systems).

Graphic Display. A graphic with 20 dynamic points shall display with current data within 10 sec.

Graphic Refresh. A graphic with 20 dynamic points shall update with current data within 8 sec. and shall automatically refresh every 15 sec.

Configuration and Tuning Screens. Screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic shall automatically refresh within 6 sec.

Object Command. Devices shall react to command of a binary object within 2 sec. Devices shall begin reacting to command of an analog object within 2 sec.

Alarm Response Time. An object that goes into alarm shall be annunciated at the workstation within 15 sec.

Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 sec. Select execution times consistent with the mechanical process under control.

Performance. Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.

Multiple Alarm Annunciation. Each workstation on the network shall receive alarms within 5 sec of other workstations.

Ownership Of Proprietary Material

Project-specific software and documentation shall become Owner's property. This includes, but is not limited to:

Graphics
Record drawings
Database
Application programming code
Documentation

Communication

Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork and/or LonWorks Technology based routers and/or network integrators manufactured by Tridium.

Install new wiring and network devices as required providing a complete and workable control network.

Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.

Internetwork operator interface and value passing shall be transparent to internetwork architecture.

An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.

Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute control strategies. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.

Controllers with real-time clocks shall use a Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated controller via the internetwork. If applicable, system shall automatically adjust for daylight saving and standard time.

System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring.

NAMEPLATES

As specified in Section 230553 provide color coded plastic laminated nameplates with engraving on or adjacent to each controller, transmitter, indicator, valve and/or damper operator, relay, sensor, switch, regulator, panel gage and elsewhere as indicated on drawings. Name plates shall identify device and loop number. Name plates for control devices shall be mounted adjacent to the device or control panel backplate using screws.

For each control loop and device furnish and install identification nameplates on loop wiring or pneumatic tubing where it enters DDC and/or control panels and at its final termination at control device. Name plate shall indicate loop number identification as noted on DDC panel schedule and P&ID's. Nameplate shall be permanently attached to control signal (wire or tube) using standard wire ties and hole penetration at both ends of the name plate.

Provide nameplates for all controls, devices, actuators and equipment interfaced with the new BAS system regardless if equipment or device is new or existing.

CONTROL WIRING

In addition to Section 230500 - General Provisions, the Contractor shall provide all control wiring and connections required for control systems. The wiring shall include the furnishing and installation of all wire, conduit, boxes, and all other necessary materials and devices required for a complete and operable installation. All materials and installation shall comply with requirements as specified in Division 26, Electrical Work and with the National Electrical Code and all applicable state and city codes and regulations. All wire for circuitry above 25 volts shall be installed in conduit and all splices and connections shall be made in boxes or device or equipment enclosures. All electrical boxes installed to serve control systems shall be painted black for that control wiring can be easily identified.

All low voltage (circuitry at 25 volts or less) wire shall be installed in conduit. All splices and connections in low voltage wiring shall be made in boxes or approved device or equipment enclosures. All electrical boxes installed to served control systems shall be painted black for that control wiring can be easily identified.

Provide all required transducers, transformers, relays, or other devices required for interface between pneumatic and electronic control equipment and as required to interface with pneumatic or electronic control systems, with the HVAC and electrical equipment, and systems being controlled.

Low voltage (25 volts and under) control wiring shall not be installed in the same conduit with higher voltage circuitry wiring. Where low voltage wiring enters the same box or enclosure with higher voltage wiring, dividers, and separation shall be provided to comply with codes and regulations, and as required to prevent malfunctions in low voltage control. Where separation of conductors for certain functions or control is recommended by the equipment or system manufacturer, then the conductors for these functions or control shall be installed in conduit separate from other conductors, regardless of voltage differential.

Operator Interface

Operator Interface. Web server shall reside on high-speed network with building controllers. Each standard browser connected to server shall be able to access all system information.

Communication. Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135-2004, BACnet Annex J.

Controller Software

Building and energy management application software shall reside and operate in system controllers. Applications shall be editable through operator workstation, web browser interface, or engineering workstation.

Scheduling. System shall provide the following schedule options as a minimum:

Weekly. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).

Exception. Operator shall be able to designate an exception schedule for each of the next 365 days. After an exception schedule has executed, system shall discard and replace exception schedule with standard schedule for that day of the week.

Holiday. Operator shall be able to define 24 special or holiday schedules of varying length on a scheduling calendar that repeats each year.

System Coordination. Operator shall be able to group related equipment based on function and location and to use these groups for scheduling and other applications.

Remote Communication. System shall automatically contact operator workstation or server on receipt of critical alarms. If no network connection is available, system shall use a modem connection.

Maintenance Management. System shall generate maintenance alarms when equipment exceeds adjustable runtime, equipment starts, or performance limits. Configure and enable maintenance.

Sequencing. Application software shall sequence chillers, boilers, and pumps.

PID Control. System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs.

Staggered Start. System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.

Anti-Short Cycling. Binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.

On and Off Control with Differential. System shall provide direct- and reverse-acting on and off algorithms with adjustable differential to cycle a binary output based on a controlled variable and setpoint.

Runtime Totalization. System shall provide an algorithm that can totalize runtime for each binary input and output. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit. Configure and enable runtime totalization and alarms as specified in Section 15900 Appendix A (Sequence of Operations).

Controllers

General. Provide Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC).. Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L.

BACnet.

Building Controllers (BCs). Each BC shall conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-BC in the BACnet Testing Laboratories (BTL) Product Listing.

Advanced Application Controllers (AACs). Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing.

Application Specific Controllers (ASCs). Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.

BACnet Communication.

Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.

BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.

Each AAC shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.

Each ASC shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.

Each SA shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.

Each SS shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using ARCNET or MS/TP Data Link/Physical layer protocol.

Communication.

Service Port. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.

Signal Management. BC and ASC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.

Data Sharing. Each BC and AAC shall share data as required with each networked BC and AAC.

Stand-Alone Operation. Each piece of equipment specified in Section 15900 Appendix A shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network.

Environment. Controller hardware shall be suitable for anticipated ambient conditions.

Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).

Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).

Keypad. Provide a local keypad and display for each BC and AAC. Operator shall be able to use keypad to view and edit data. Keypad and display shall require password to prevent unauthorized use. If the manufacturer does not normally provide a keypad and display for each BC and AAC, provide the software and any interface cabling needed to use a laptop computer as a Portable Operator's Terminal for the system.

Real-Time Clock. Controllers that perform scheduling shall have a real-time clock.

Serviceability.

Controllers shall have diagnostic LEDs for power, communication, and processor.

Wires shall be connected to a field-removable modular terminal strip or to a termination card connected by a ribbon cable.

Each BC and AAC shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.

Memory.

Controller memory shall support operating system, database, and programming requirements.

Each BC and AAC shall retain BIOS and application programming for at least 72 hours in the event of power loss.

Each ASC and SA shall use nonvolatile memory and shall retain BIOS and application programming in the event of power loss. System shall automatically download dynamic control parameters following power loss.

Immunity to Power and Noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft.).

Transformer. ASC power supply shall be fused or current limiting and shall be rated at a minimum of 125% of ASC power consumption.

Input and Output Interface

General. Hard-wire input and output points to BCs, AACs, or, ASCs.

Protection. Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point contact with up to 24 V for any duration shall cause no controller damage.

Binary Inputs. Binary inputs shall monitor the on and off signal from a remote device. Binary inputs shall provide a wetting current of at least 12 mA and shall be protected against contact bounce and noise. Binary inputs shall sense dry contact closure without application of power external to the controller.

Pulse Accumulation Inputs. Pulse accumulation inputs shall conform to binary input requirements and shall accumulate up to 10 pulses per second.

Analog Inputs. Analog inputs shall monitor low-voltage (0-10 Vdc), current (4-20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.

Binary Outputs. Binary outputs shall send an on-or-off signal for on and off control. Building Controller binary outputs shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.

Analog Outputs. Analog outputs shall send a modulating 0-10 Vdc or 4-20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two-position (auto-manual) switch, a manually adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.

Tri-State Outputs are not allowed on this project.

Universal Inputs and Outputs. Inputs and outputs that can be designated as either binary or analog in software shall conform to the provisions of this section that are appropriate for their designated use.

CONTROL WIRING & control panels

In addition to Section 230500 - General Provisions and Division 26 of these specifications the Contractor shall provide control panels, wiring and connections required for control systems. The wiring shall include the furnishing and installation of all wire, conduit, boxes, and all other necessary materials and devices required for a complete and operable installation. All materials and installation shall comply with requirements as specified in Division 26 Electrical Work and with the National Electrical Code and all applicable state and city codes and regulations. All wire for circuitry above 25 volts shall be installed in conduit and all splices and connections shall be made in boxes or device or equipment enclosures. All electrical box covers installed to served control systems shall be painted black so that control wiring can be easily identified.

All low voltage (circuitry at 25 volts or less) wire located in mechanical rooms and areas with exposed structure shall be installed in conduit. All splices and connections in low voltage wiring shall be made in boxes or approved device or equipment enclosures.

Pain all conduit to match adjacent systems where conduit systems are installed in areas where the structure is exposed and existing MEP equipment has been painted

Provide all required transducers, transformers, relays, or other devices required for interface between pneumatic and electronic control equipment and as required to interface with pneumatic or electronic control systems, with the HVAC and electrical equipment, and systems being controlled.

Low voltage (25 volts and under) control wiring shall not be installed in the same conduit with higher voltage circuitry wiring. Where low voltage wiring enters the same box or enclosure with higher voltage wiring, dividers, and separation shall be provided to comply with codes and regulations, and as required to prevent malfunctions in low voltage control. Where separation of conductors for certain functions or control is recommended by the equipment or system manufacturer, then the conductors for these functions or control shall be installed in conduit separate from other conductors, regardless of voltage differential.

TEMPERATURE SENSORS

All temperature sensors shall be resistance temperature detectors with platinum sensing elements having a resistance of 100 ohms or higher and at 32°F. an accuracy of 0.5°F or better through the range of 40°F to 120°F. Sensors shall be vibration and corrosion resistant, encapsulated in epoxy, series 300 stainless steel, anodized aluminum or copper.

Pipe insertion type sensors for installation in water systems shall have extension element with bulb and insertion well. The Contractor is responsible for installation of wells, where not previously provided, in existing piping systems. The probe of the sensor shall be constructed of stainless steel and sized to reach the end of the well. The well shall be constructed of stainless steel and sized to reach into the center of the pipe. Thermowell shall have variable extension for pipe insulation and threaded connection to pipe. Maximum length shall be 6" or ¾ of pipe diameter whichever is smaller. Pipes with small diameters shall have the well mounted at a 90° elbow to allow sufficient contact with the fluid. At the time of final installation of the probe ensure that the well is filled with a heat transfer compound. Sensors shall be removable without shutting down the system in which they are installed.

All temperature sensors with the exception of room sensors shall include transmitters to create a 4-20 ma control loop signal. Sensor control loop shall interface directly with DDC panels without the use of additional transducers or signal converters.

Manufacturers:

MAMAC
Vaisala Inc.
Rotronic

room sensors for Fan terminal vav units

Refer to the plans for all locations of temperature sensors and type.

Sensors shall have 10K ohm thermistor with +0.36 deg F standard accuracy and less than 0.18 deg F drift over a ten year span – and require no re-calibration.

Sensors shall have a hidden communication port to allow a laptop computer to be connected to the HVAC control system.

All patient rooms and wings shall have (predominantly): room sensors shall have a local setpoint adjustment through an east to use slide potentiometer. Occupancy override shall use momentary push button with a bright LED for immediate indication of status. When override is pressed during an occupied mode, the zone shall revert to an occupied setpoint for a predetermined period of time.

All large areas in GSA space: room sensors shall have a large, easy-to-read LCD to display zone temperature, outside air temperature, heating setpoint, cooling setpoint, and local override (after-hours occupancy) time. Occupancy override shall use "manual on" momentary pushbutton. A single push shall switch the zone to an occupied mode for a preset period of time. Multiple pushes increase the override time, and the LCD displays precisely how long the zone with stay occupied (adj). Zone setpoints shall be changed by pressing "warmer" or "cooler" button (maximum adjustable). Pressing the "fan speed" button shall incrementally adjust the fan speed of the fan coil unit. The "mode" button can be used to select among several zone operation modes as programmed.

HUMIDITY SENSORS

Furnish and install new space and duct humidity sensors as indicated in the control sequences and as shown on drawings. In general humidity sensors shall be used for control of the duct mounted steam humidifiers and alarm on high and low humidity limits in the space and supply ducts.

Humidity sensors shall be electronic. Pneumatic sensors are not acceptable. Space and duct air sensors shall be accurate to ± 2% RH between 20% and 100% RH. Sensors shall have a repeatability of 0.5% RH, Linearity: ±1% of span and Response less than 2 min for full span output and hysteresis of 0.5% or better. Sensors shall be furnished with transmitter for 4-20mA output signal.

Manufacturers:

MAMAC
Rotronic
Vaisala Inc.

Verris

DUCT MOUNTED SMOKE DETECTORS

The duct detector shall be photoelectric type, and shall obtain its power from and communicate with the existing Early Warning Firing Detection (EWFD) panel. A front cover mounted LED shall indicate an alarm condition.

Detector shall be furnished with sample tube having an insect screen to minimize nuisance alarms and shall be designed to ignore invisible airborne particles or smoke densities below factory setpoint. Sampling tube shall be securely mounted and attached at both ends.

Detector construction shall have a mounting base with a twist lock detecting head. Removal of detecting head shall cause a trouble signal at the EWFD panel. For maintenance purposes, it shall be possible to clean the duct housing sampling tubes by accessing them through the housing front cover.

The detector electronics shall be immune to false alarms cased by EMI or RFI.

Provide two single pole double throw alarm relay contacts for each detector.

Provide duct-type detector in both the supply and return connection for all air handling equipment greater than 2,000 CFM.

ELECTRIC ACTUATORS

Provide electric actuators for control dampers, control valves smaller than 3” and elsewhere as indicated on drawings.

Edit above and below to suit specific project requirements.

Electric actuators shall be direct-coupled type. Damper actuators shall be mounted directly to the damper shaft without the need for connecting linkage. Actuators shall include electronic overload or digital rotation sensing circuitry to prevent damage to the actuators throughout the entire rotation of the actuator.

Actuators serving outdoor air dampers, chilled water control valves and cross-over dampers, air handling unit discharge dampers and elsewhere as shown on drawings shall have spring return mechanism built in into the actuator housing.

All spring return actuators shall be capable of both clockwise or counterclockwise spring return operation by simple changing the mounting orientation.

Actuators shall have an arrow identification indication the position of actuator

Actuator exposed to the outdoors shall be provided with 304 stainless steel housing with a neoprene gasketed door. Housing shall have a NEMA 4X ratting and suitable for outdoor installation.

Proportional actuators shall accept a 0 to 10 VDC or 0 to 20 mA control input signal and provide a 2 to 10 VDC or 4 to 20 mA operating range. Actuators capable of accepting a pulse width modulating control signal and providing full proportional operation are acceptable.

All actuators shall provide a 2 to 10 VDC position feedback signal.

All modulating actuators shall have an external, built-in switch to all the reversing of direction rotation.

Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuators rated torque.

All non-spring return actuators shall have an external manual gear release to allow manual positioning when the actuator is not powered. Spring return dampers with more than 60 in-lb. torque capacity shall have a manual crank for this purpose.

Manufacturers

Belimo

Alerton

Automated Logic

Johnson Controls

CURRENT SWITCHES

Current switches shall be utilized for fans and pumps for flow status indication to Building Control System. Current switches shall be designed and rated for the maximum amp draw of the device being monitored.

Current switches shall indicate the presence of electrical power by monitoring the amps of the conductor feeding motor of the fan or pump. The control range for the device shall be such that the failure of belts on a belt driven fan shall indicate an alarm.

Manufacturers:

Verris – Hawkeye

DIFFERENTIAL PRESSURE SWITCHES

Differential pressure switches shall have sensors on inlet and outlet side of fans and pumps for flow status indication to BAS. Differential pressure switches shall be designed and rated for the maximum pressure range and shall be adjustable at the device.

Differential pressure switches for air and gas systems shall be diaphragm operated with 4" diaphragm to actuate a SPDT snap switch. Motion of diaphragm shall be restrained by a calibrated spring that can be adjusted to set the exact pressure differential at which the electrical switch will be actuated. Motion of the diaphragm shall be transmitted to the switch button by means of direct mechanical linkage.

Differential pressure switches for water or liquid shall be operated by two opposing bellows of type 316 stainless steel. Bellows shall actuate SPDT snap acting switch via direct mechanical linkage. High and low pressure setpoints shall be visible and externally adjustable.

Manufacturers:

Dwyer – Air or gas: Series 1800
Mercoid – Water or liquid: Series DP

STATIC PRESSURE TRANSMITTERS

All pressure transmitters for sensing static pressure in ductwork, fan discharge and space as specified herein shall be of the electronic type and provide an output signal of 4 to
20 mA. Pressure sensors shall include multiple sensing ports, pressure impulse suppression chamber of at least 50 in³, airflow shielding and ⅜” compression takeoff fitting, all contained in a welded steel casing.

Pressure transmitters shall provide a signal to the duct static pressure controllers. Pressure transmitters shall have an accuracy of ± 1% of full scale or better and a repeatability of 0.3% of full scale or better. The effect of ambient temperature variations shall be less than .033% of full scale for ambient temperature changes from 40°F to 100°F when calibrated at 70°F.

Manufacturers:

Setra
Air Monitor Corp.
Dwyer Series 607

CO2 Sensors

Provide CO2 sensors for sensing levels of carbon dioxide in air. Sensors shall have a measuring range of 0 – 2000 parts per million (ppm) at a tolerance of ± 100 ppm, and provide 0 – 10 VDC linear output.

Where indicated on drawings, provide duct mounting kit for CO2 sensors, in proper orientation as indicated by manufacturer, and in location for serviceability.

INSTALLATION

Locate controls, relays, instruments, switches, valves, devices and accessories so they are readily accessible for adjustment, service and replacement, or as indicated.

Install control valves with power unit up.

Air sensing elements:

Locate, size and support temperature sensing elements in air streams to properly sense representative temperature.

For controlling, transmitting and indicating elements, locate, size, and select type of sensing device to sense average condition.

Sensing elements in double wall casings and insulated ducts shall have entire active portion within air stream.

Insulated surfaces:

Where insulation on ductwork or equipment is punctured or penetrated due to installation of sensing elements or tubing, re-seal openings air and vapor tight.

Where control devices are located on insulated surfaces, provide brackets to clear finished surface of insulation avoiding punctures of vapor seal.

Limitations:

Locate, support, enclose and install control devices and equipment so as not to subject to vibration, excessive temperatures, dirt, moisture or other harmful effects or conditions beyond their rated limitations.

If devices must be located subject to conditions beyond their recommended or rated limitations, provide necessary protective enclosures and/or furnish equipment constructed of materials and features capable of withstanding adverse conditions.

Taps:

Install pressure sensing taps on fluid lines in straight runs of pipe with minimum length of 10 pipe diameters both upstream and downstream of pressure tap.

Provide shut-off cock in sensing line at each pressure tape.

Provide isolating seal where fluid can injure measuring element.

Control valves, damper operators:

Install control valve and damper operators capable of smoothly positioning under load through full ranges and strokes indicated in both directions without binding or fluttering, and be further capable of holding steady in any intermediate or extreme position while respective systems are functioning at design flows, temperature and pressures.

INSTRUCTIONS TO OWNER & SYSTEM TRAINING

The Contractor shall submit a detailed proposed training plan to the Engineer and Owner for review and approval before commencement of training. Training plan shall outline all training sessions content and duration.

Training manuals (minimum of 8 required) shall be provided in loose-leaf binders and shall include all necessary documentation for Host computer operation, DDC panel operation and Maintenance data.

The Contractor shall provide a minimum of 5 full days of training to the owner's staff on the operation of the control systems installed. Training may be spread out over a period of several days to accommodate owners staff requirements. Formal training shall be provided once system installation is complete and prior to acceptance of the system by Owner. Training shall include but not limited to the following:

Owner personnel shall participate during the installation, software generation, system validation, system commissioning and start-up of the BAS.

Owner training shall be provided on a formalized basis and as an integral task within project contract requirements. Training at a minimum shall be divided into four separate categories as follows:

Host computer and operator workstation training.

DDC panel operation, trouble shooting and maintenance.

Loop control, tuning and control device calibration.

For each typical control loop instruct the owner on operation and calibration of each device. Document proportional and integral settings for each PID loop and instruct owners staff on calibration adjustments and trouble shooting of electronic control systems.

Instruct owner on operation and maintenance for each control device and demonstrate calibration technique.

Contractor shall provide Owner training on I/O point definition, software strategy, system backup procedures and system down loading procedure.

Contractor shall provide Owner training on the operation and usage of the Host Computer system. Training shall include explanation of all required DOS commands as well as system software commands. Training shall include hardware operation, peripheral devices and components, report generation, software modification techniques and graphic generation and modification techniques.

Owner training shall include operation and function of LAN system used for communication between DDC panels and host computer systems.

EXECUTION

Not Used

END OF SECTION 230923

SECTION 23 09 93 – SEQUENCES OF OPERATION

GENERAL

Description of Work

HVAC Control Sequences described herein indicate the manner and chronological sequence in which, and methods by which, automatic, temperature controls function.

The BAS control system installed under this project shall be programmed to provide the intent of the sequences described herein. The BAS shall be furnished and installed complete and shall be properly adjusted and programmed to perform all sequences, functions, and status indications for all equipment and systems as herein specified and as indicated on drawings and as required by existing conditions.

control sequence

Heating Hot Water Plant (B-1, b-2, HhWP-1, hhwp-2)

General System Operation

1. *The Heating Hot Water Plant is comprised of three Gas-Fired Boilers (B-1 & B-2) each with a dedicated Heating Hot Water Pump (HWP-1 & HHWP-2). When in operation the boilers manufacturer provided controls shall control to maintain the leaving hot water setpoint.*

Heating Hot Water Plant Modes of Operation:

System Scheduling - The Heating Hot Water Plant control algorithms shall employ advanced schedule/calendar architecture to facilitate scheduled occupied/unoccupied modes of operation. The schedule/calendar shall provide the ability to setup up diverse schedules of operation based on special events, holidays, and normal operation.

Occupied Mode: While operating in the occupied mode and the Heating Hot Water Plant is allowed to operate the plant will be continuously enabled and controlling to maintain the leaving hot water temperature at the desired setpoint.

Unoccupied Mode: While operating in the unoccupied mode if any Air Handling Unit served by the Heating Hot Water Plant begins operation in the unoccupied mode, the Heating Hot Water Plant is allowed to operate, and the running unit requires heating hot water the plant shall enable.

Outside Air Number of Boilers: The number of boilers allowed to operate will be based upon the outside air temperature. If the outside air temperature is greater than or equal to 35 degrees (Adj.) only the lead boiler shall operate. If the outside air temperature is less than 35 degrees (Adj.) then all three boilers shall be allowed to operate and staged up/down accordingly to return water temperature.

Outside air reset : the leaving water setpoint shall be reset based upon the following:

<20°F --> 160°
20-30° --> 150°
30-40° --> 140°
40-50° --> 130°

Plant Initialization:

Lead/Lag: Boilers and pumps shall switch lead/lag based upon equipment runtimes. The runtime switch shall initiate when equipment runtime has reached 300-hrs (Adj.)

Upon a plant initiation command if all safeties are in the "Normal Position" the Lead Heating Hot Water Pump shall be enabled. Upon a proof of Lead Pump operation an enable command shall be sent to the Lead Boiler.

If the number of boilers allowed to operate based upon outside air temperature is greater than 1 and the heating hot water supply temperature is 5 degrees (Adj.) below the heating hot water supply temperature setpoint of 160 degrees (Adj.) for 30-minutes (Adj.) then the Lag Heating Hot Water Pump shall be enabled. Upon a proof of Lag Pump Operation and enable command shall be sent to the Lag Boiler.

If at any point the boiler command is enabled and boiler status is False for 2-minutes (Adj.) the boiler shall go into shutdown alarm. The Lag boiler and pump shall immediately enable. The failed boiler shall require a software reset after the alarm event has been cleared in order to operate.

Plant Shutdown:

While the system is operating with 2-boilers and the measured Heating Hot Water Supply Temperature rises above the Heating Hot Water Supply Temperature Setpoint for 30-minutes the Lag boiler shall shutdown.

When the plant issues a shutdown command to either the Lead or Lag Boiler it shall be disabled and the Heating Hot Water Pump operating with the Boiler shall remain commanded for 1-hr (Adj.).

FAN COILS

General:

The units are new constant volume units with supply fan, chilled water cooling, electric heating.

Sequence:

The supply fan shall be commanded "on" using automatic programming based on time of day and day of week. The schedule shall encompass override capabilities from local temperature sensors connected to the fan powered boxes.

When commanded on if the smoke detector, high pressure switch, and freeze stats are in their normal state the supply fan motor shall energize. Once airflow has been proven supply fan speed controls shall engage and the outdoor air damper shall modulate to its minimum position (minimum damper position shall be field determined), the return air damper shall modulate proportionally to the outside air damper.

Cooling control – The chilled water valve shall modulate open to maintain room temperature setpoint. This shall be from a rise of more than 1.5 degree (deadband) from setpoint.

Heating control – The electric heating coil shall stage to maintain room temperature setpoint. This shall be from a drop of more than 1.5 degree (deadband) from setpoint.

Alarms & Safeties:

Freeze stat shall be installed upstream of the chilled water coil where indicated on plans. The freeze stat shall be hardwired interlocked with the supply fan and shall also be interfaced with the respective local DDC panel.

Upon activation of the freeze stat the unit supply fan shall de-energize, the mixed air dampers shall return to their normal position, and the chilled water control valve shall fully open allowing full flow through the coil.

If the mixed air temperature drops to 45°F as sensed by the mixed air temperature sensor the DDC panel shall initiate an alarm warning to the operator. Alarm shall indicate that the mixed air temperature has reached a critical low limit.

Dirty Filter Switch. When the pressure differential across the filter section exceeds the setpoint a dirty filter alarm shall be generated.

Fan Failure: When the fan command is true and the fan status is false a fan failure alarm shall be generated.

Fan in Hand: When the fan command is false and the fan status is true a fan in hand alarm shall be generated.

High Pressure Switch: If the high pressure switch activates the fan shall de-energize and the mixed air dampers shall return to their normal positions. An alarm shall be generated.

Smoke Detector: If the duct mounted smoke detector activates the fan shall de-energize and the mixed air dampers shall return to their normal positions. An alarm shall be generated.

radiant floor heating system

General:

The floor system shall be provided with factory controls for zone pumps, zone temperature sensors, and HWS/HWR temperature sensors. These shall have the capability of running local and stand-alone without the use of a BAS.

Sequence:

The radiant floor heating system shall be locked out for any temperatures above 55 deg F.

For each heating zone, a space temperature sensor (with LCD screen) shall be installed and tied to the Watts Radiant control system, and shall operate zone pumps and control injection pump.

Alarm:

For any zone temperature drop below 45 deg F.

For any alarms generated with factory controls (via integration).

heating ventilator unit

General:

Roof top unit is a new variable volume 100% ventilation unit with gas heating coil and motorized dampers.

Sequence:

Upon receiving a call to start the supply fan, the motorized outdoor air damper shall open. The fan shall not engage until damper has proven to be open.

Summer ventilation: For any temperature above 55 deg F (adj), the supply fan shall be in operation at full design CFM, maintaining space ventilation temperature via sensor. This fan shall lead the garage airflow and be in operation at any point the shop exhaust fan is in operation. The overall supply air CFM shall be approximately 5% more than tracking exhaust fan.

For any outdoor air temperature below 55 deg F (adj):

In the event that the space mounted CO/NO2 (Carbon Monoxide) sensor rises above 30 PPM (adj), the supply fan shall speed shall increase until the level drops below the gas detection setpoint.

When all gas detection systems are stable and satisfied, the speed on the supply fan VFD shall fall to minimum setpoint (constant volume) of 25% airflow (or 1900 cfm)

Night setback:

Based upon a time of day programming, the HV1 shall be off for unoccupied areas. Upon either a rise in CO/NO2 to above 35 PPM, or during winter temperature falls below 45 deg F, the night setback mode shall be overridden to normal operation.

Gas Heating:

Below 55 deg F: The direct gas furnace shall modulate in sequence satisfy the duct mounted supply air temperature sensor at a setpoint of 65°F (Adj.).

Alarms & Safeties:

If the mixed air temperature drops to 45°F as sensed by the mixed air temperature sensor the DDC panel shall initiate an alarm warning to the operator. Alarm shall indicate that the mixed air temperature has reached a critical low limit.

Dirty Filter Switch. When the pressure differential across the filter section exceeds the setpoint a dirty filter alarm shall be generated.

Fan Failure: When the fan command is true and the fan status is false a fan failure alarm shall be generated.

High Pressure Switch: If the high pressure switch activates the fan shall deenergize and the mixed air dampers shall return to their normal positions. An alarm shall be generated.

Smoke Detector: If the duct mounted smoke detector activates the fan shall deenergize and the mixed air dampers shall return to their normal positions. An alarm shall be generated.

exhaust fan (hanger)

General:

The exhaust fan is a variable volume application.

Controls include a CO/NO2 Sensor and variable frequency drive.

An outdoor air sensor shall be installed for this building and local controls.

Sequence:

Upon receiving a call to start the exhaust fan, the motorized exhaust damper shall open. The fan shall not engage until damper has proven to be open.

For any temperature above 55 deg F (adj), the exhaust fan shall be in operation at full design CFM, maintaining space ventilation temperature via sensor. This fan shall track the supply air handling unit fan and be in operation at any point the HV-1 unit is in operation.

For any outdoor air temperature below 55 deg F (adj):

In the event that the space mounted CO/NO2 (Carbon Monoxide) sensor rises above 30 PPM (adj), the exhaust fan shall speed shall increase until the level drops below the gas detection setpoint.

When all gas detection systems are stable and satisfied, the speed on the exhaust fan VFD shall fall to minimum setpoint (constant volume) of 25% airflow (or 1750 cfm)

Night setback:

Based upon a time of day programming, the exhaust fan shall be off for unoccupied areas. Upon either a rise in CO/NO2 to above 35 PPM, or during winter temperature falls below 45 deg F, the night setback mode shall be overridden to normal operation.

Alarms & Safeties:

CO Alarm: Upon activation of the space mounted CO sensor an alarm shall be generated.

Fan Failure: Upon activation of the space mounted CO sensor if the exhaust fan status is not proven within 30-seconds (Adj.) an alarm shall be generated.

outdoor lighting

Run conditions: The lighting output shall turn on and off based upon the local sunrise and sunset times. The transitions shall be configurable.

General Exhaust Systems

General:

General Exhaust Systems consist of an exhaust fan.

Modes of Operation:

System Scheduling - The Exhaust Fan control algorithms shall employ advanced schedule/calendar architecture to facilitate scheduled occupied/unoccupied modes of operation. The schedule/calendar shall provide the ability to setup up diverse schedules of operation based on special events, holidays, and normal operation.

Occupied Mode: While operating in the occupied mode the exhaust fan will be continuously enabled and monitored.

Unoccupied Mode: While operating in the unoccupied mode the exhaust fan will be commanded off.

Sequence of Operation – Exhaust Fan VFD:

When operating in the occupied mode the exhaust fan shall be continuously enabled.

Sequence of Operation – Alarms:

General: All alarm events shall incorporate adjustable time delays.

Fan Alarms: Whenever the unit status and command do not match an alarm shall be generated.

If the unit is commanded off and the fan status is true a fan not in auto alarm shall be generated. The unit shall continue controlling in automatic while status is true.

If at any point the fan command is enabled and fan status is false the unit shall go into shutdown alarm. The unit shall require a software reset after the alarm event has been cleared in order to operate.

PART 3 – EXECUTION

NOT USED.

END OF SECTION

SECTION 23 11 23 - NATURAL GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.
2. Service Regulators: 100 psig minimum unless otherwise indicated.

B. Natural-Gas System Pressure within Buildings: More than 0.5 psig but not more than 2 psig.

C. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.

D. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Design Submittal: For natural-gas piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation as required per local authorities.

1. Detail fabrication and assembly of seismic restraints.
2. Design Calculations: Calculate requirements for selecting seismic restraints.

C. Welding certificates where applicable.

1.4 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
    a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

B. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Parker Hannifin Corporation; Parflex Division.
    b. Tru-Flex Metal Hose Corp.
2. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
3. Coating: PE with flame retardant.
    a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
        1) Flame-Spread Index: 25 or less.
        2) Smoke-Developed Index: 50 or less.
4. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
5. Striker Plates: Steel, designed to protect tubing from penetrations.
6. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
7. Operating-Pressure Rating: 5 psig.

C. Annealed-Temper Copper Tube: Comply with ASTM B 88, Type K.

1. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
2. Flare Fittings: Comply with ASME B16.26 and SAE J513.
    a. Copper fittings with long nuts.
    b. Metal-to-metal compression seal without gasket.
    c. Dryseal threads complying with ASME B1.20.3.

3. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of 0.022 inch thick.

D. PE Pipe: ASTM D 2513, SDR 11.

1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
3. Anodeless Service-Line Risers: Factory fabricated and leak tested.
    a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
    b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. Vent casing aboveground.
    c. Aboveground Portion: PE transition fitting.
    d. Outlet shall be threaded or suitable for welded connection.
    e. Tracer wire connection.
    f. Ultraviolet shield.
    g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
4. Transition Service-Line Risers: Factory fabricated and leak tested.
    a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
    b. Outlet shall be threaded or suitable for welded connection.
    c. Bridging sleeve over mechanical coupling.
    d. Factory-connected anode.
    e. Tracer wire connection.
    f. Ultraviolet shield.
    g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches.

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.

5. Adjustable, retractable restraining cable.

C. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller.
3. Strainer Screen: [40] [60]-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

D. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.4 MANUAL GAS SHUTOFF VALVES

A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1. CWP Rating: [125 psig].
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
6. Service Mark: Valves 1.25 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

C. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. BrassCraft Manufacturing Company; a Masco company.
   b. Conbraco Industries, Inc.; Apollo Div.
   c. Perfection Corporation; a subsidiary of American Meter Company.
2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated brass.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Separate packnut with adjustable-stem packing threaded ends.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. BrassCraft Manufacturing Company; a Masco company.
   b. Conbraco Industries, Inc.; Apollo Div.
   c. Perfection Corporation; a subsidiary of American Meter Company.
2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. BrassCraft Manufacturing Company; a Masco company.
   b. Conbraco Industries, Inc.; Apollo Div.
   c. Perfection Corporation; a subsidiary of American Meter Company.
2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.

5. Seats: Reinforced TFE.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Bronze Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Lee Brass Company.
   b. McDonald, A. Y. Mfg. Co.
2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.5 DIELECTRIC UNIONS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Capitol Manufacturing Company.
2. Hart Industries International, Inc.
3. Watts Regulator Co.; Division of Watts Water Technologies, Inc.

B. Minimum Operating-Pressure Rating: 150 psig.

C. Combination fitting of copper alloy and ferrous materials.

D. Insulating materials suitable for natural gas.

E. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

2.6 SLEEVES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.7 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Advance Products & Systems, Inc.
   b. Calpico Inc.
   c. Metraflex Company (The).
   d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.
3. Pressure Plates: Carbon steel.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

2.8 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 OUTDOOR PIPING INSTALLATION

A. Comply with NFPA 54 for installation and purging of natural-gas piping.

B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. Install underground, PE, natural-gas piping according to ASTM D 2774.

D. Steel Piping with Protective Coating (Underground):

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
3. Replace pipe having damaged PE coating with new pipe.

E. Copper Tubing with Protective Coating:

1. Apply joint cover kits over tubing to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.

F. Install fittings for changes in direction and branch connections.

G. Exterior-Wall Pipe Penetrations: Seal penetrations using steel or cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

H. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

I. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

J. All exterior gas piping shall be painted with one primer coat and two (2) finish coats.

3.2 INDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas. Where exposed in finished spaces, all piping shall be painted.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access. No running threaded joints or valves shall be installed in a return air plenum.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

L. Verify final equipment locations for roughing-in.

M. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

N. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

O. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

P. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view. No joints will be allowed in concealed locations per code requirements.

Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

R. Connect branch piping from top or side of horizontal piping.

S. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment.

T. Do not use natural-gas piping as grounding electrode.

U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

V. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

3.3 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install earthquake valves aboveground outside buildings according to listing.

E. Install anode for metallic valves in underground PE piping.

3.4 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
4. All piping 2 psi or greater shall have welded fittings.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

G. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.5 HANGER AND SUPPORT INSTALLATION

A. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 0.375-inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 0.375-inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 0.375-inch.

B. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:

1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 0.375-inch.
2. NPS 1/2: Maximum span, 72 inches; minimum rod size, 0.375-inch.
3. NPS 3/4 and Larger: Maximum span, 96 inches; minimum rod size, 0.375-inch.

3.6 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements. Include all costs, charges, fees incurred by local authorities into bid.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.7 LABELING AND IDENTIFYING

A. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for piping and valve identification. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.8 FIELD QUALITY CONTROL

A. Test, inspect, and purge natural gas according to NFPA 54 and the International Fuel Gas Code and authorities having jurisdiction.

B. Natural-gas piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.9 OUTDOOR PIPING SCHEDULE

A. Reference piping material schedule on drawings.

3.10 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

B. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

C. Valves in branch piping for single appliance shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

END OF SECTION 231123

SECTION 232113 – HYDRONIC PIPING

GENERAL

DESCRIPTION OF WORK

Chilled Water and Heating Hot Water Piping (Above Ground)

Condensate Drain Piping

Piping specialties:

Unions

Strainers

QUALITY ASSURANCE

All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications. Welding procedures and testing shall comply with ANSI Standard B31.1.0 - Standard Code for Pressure Piping, Power Piping, and the American Welding Society, Welding Handbook. Soldering and Brazing procedures shall conform to ANSI B9.1 Standard Safety Code for Mechanical Refrigeration.

All materials to be incorporated into a permanent piping system shall be new and undamaged. The piping shall be installed as shown on the design drawings and shall run either parallel or perpendicular to the building structure. All new piping shall be installed to allow for expansion and contraction without undue stress on the piping and pipe hangers.

Unions: All piping unions shall be of the ground joint type constructed of materials equivalent in alloy composition and strength to other fittings in the piping systems in which they are installed. Union pressure classes and end connections shall be the same as the fittings in the piping systems in which they are installed. Steel unions shall have hardened stainless steel seating surfaces on both faces. Unions shall be dielectric where connecting dissimilar metals together.

Unless specified otherwise, steel pipe shall be Grade A120 or Grade A53, conforming to ASTM Specifications and ANSI Specifications. All steel piping shall bear ASTM stamp on pipe. Piping not bearing ASTM stamp shall be removed and new piping shall be installed in accordance with these specifications.

Fittings shall be standard screwed type or screwed flange type for threaded pipe and standard steel welding type for welded pipes. Piping systems, fittings, valves, and specialty items and accessories shall be furnished, installed and rated for not less than the minimum water working pressure and hydrostatic test pressure specified for each piping system.

SUBMITTALS

Submit shop drawings for all piping materials in accordance with Division 1, Section 013300.

Shop Drawings:

Submit shop drawings which indicate complete material data.

Product Data:

Provide current manufacturer's data to show compliance with these specifications and governing regulations.

EQUIPMENT

JOINING MATERIALS

Welding materials shall comply with Section II, Part C ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded. All welding shall be done in accordance with Owner requirements as specified in Division 1.

Brazing materials shall comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials appropriate for the materials being joined. For copper tube and fitting joints, braze joints in accordance with ANSI B31.1.0

Gaskets for flanged joints shall be full-faced for cast-iron flanges and raised faced for steel flanges. Select materials to suit the service of the piping system in which installed and which conform to their respective ANSI Standard. Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

CHILLED WATER AND HEATING HOT WATER PIPing (Above Ground)

Chilled water supply and return, hot water heating supply and return piping, condenser water piping less than 12-inches shall be Schedule 40 black steel pipe. Pipe size 1¼" and smaller shall be installed with screwed fitting and joints. Piping 1½" size through 3" size shall be installed with screwed, grooved, or welded joints and fittings. Pipe size 3½" and larger shall be installed with grooved or welding fittings and joints. Provide flanges where required for flanged connections. Leak test piping systems with 150 psi hydrostatic pressure.

At Contractors option, pipe size ½" to 6" may be grooved joints with Victaulic fittings.

All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

All castings used for coupling housings, fittings, and valve bodies shall be date stamped for quality assurance and traceability.

Grooved Joints shall be installed in accordance with the manufacturer's published installation instructions, on applicable piping systems.

Gaskets shall be verified as suitable for the intended service. Lubricate gasket in accordance with manufacturer's recommendations with a lubricant supplied by the coupling manufacturer that is compatible with the gasket elastomer and fluid media. Basis of Design: Victaulic Vic-Lube.

Grooved joint fittings shall be manufactured of ductile iron in accordance with ASTM A536; wrought steel to ASTM A234; or factory-fabricated from steel pipe conforming to ASTM A53. Fittings for use with copper-tubing systems shall comply with ASME B16.22 wrought copper or ASME B16.18 cast bronze, with copper-tubing sized grooved ends. (Flaring tube or fitting ends to accommodate alternate sized couplings is not permitted.)

Grooved joint couplings shall consist of two ductile iron housing segments to ASTM A536, pressure responsive gasket to ASTM D2000, and zinc electroplated steel bolts and nuts to ASTM A449. Couplings shall comply with ASTM F1476 Standard Specification for the Performance of Gasketed Mechanical Couplings for Use In Piping Applications.

Rigid Type: Coupling housings shall be cast with offsetting, angle-pattern bolt pads to provide joint rigidity and support and hanging in accordance with ANSI B31.1 and B31.9.

i. Victaulic Style 107H, Installation-Ready, for direct stab installation without field disassembly, with grade EHP gasket, suitable for water service to +250 deg F.

ii. Victaulic Style 07 “Zero-Flex”

Flexible Type: For use in locations where vibration attenuation and stress relief are required, and for the elimination of flexible connectors. Victaulic Installation-Ready Style 177 or Style 77.

14-inches and Larger: AGS Series, with lead-in chamfer on housing key and wide width FlushSeal gasket. Victaulic Style W07 (rigid) and Style W77 (flexible).

Couplings for copper tubing shall be cast with offsetting, angle-pattern bolt pads to provide joint rigidity, Installation-Ready, for direct stab installation without field disassembly, with grade EHP gasket, suitable for water service to +250 deg F. Victaulic Style 607H.

CONDENSATE DRAIN PIPing

Drain lines for condensate drain pans shall be Type 'M' or Type 'L' rigid copper tubing with sweat solder fittings and joints. Provide trap formed from pipe and fittings in all air supply unit coil drain pan drain lines. Traps shall be constructed and installed in accordance with the air handling unit manufacturer's recommendations.

UNIONS

Unions for use in ferrous pipe shall be malleable iron with brass to iron ground joint spherical seat, screwed ends, and rated for not less than 300 psi water working pressure.

Unions for use with copper piping shall be cast brass or cast bronze with ground joint spherical seat and with cast brass or bronze or wrought copper sweat ends.

Unions shall be installed wherever necessary for replacement or repair of equipment, valves, strainers, etc. Right and left hand couplings are not acceptable.

Unions in refrigerant systems shall be designed for a maximum 400 psig working pressure, 330°F maximum operating temperature; two brass tailpiece adapters for solder end connections to copper tubing. Flanges for 7/8" to 1-5/8" unions shall be forged steel, and for 2-1/8" rough 3-1/8" shall be ductile iron; four plated steel bolts, with silicon bronze nuts and fiber gasket. Flanges and bolts shall have factory applied rust resistant coating.

Dielectric isolating type unions shall be installed wherever ferrous piping is connected to copper or copper alloy equipment or copper piping. Dielectric unions shall be rated for not less than 250 psi W.P.

Furnish and install dielectric unions at all locations where copper piping material is connected to any dissimilar metal. Piping, piping materials, component arrangement and installation procedures must provide and accommodate points at which dielectric breaks fully segregate dissimilar metals.

Fittings used shall be union type, of size and materials as required for service involved. Gaskets for fittings shall conform to manufacturer's recommendations for the intended service. Fittings shall meet all requirements of ASNI B16.8 and shall, as a minimum, be capable of effectively isolating stray electrical currents up to 600 volts.

Manufacturer

EPCO Sales Company
Victaulic Company Style 47

STRAINERS

Strainers, unless specified otherwise or shown on drawings otherwise, shall be basket or "Y" type of same size as pipe line and with cast iron body, direction of flow arrow cast in body, and removable screen of not less than .0625 inch thick (22 gauge) sheet brass perforated for total net free area opening equal to four times the area of pipe. Strainers shall have bodies drilled and tapped for drain and blow-down. Furnish and install drain valve with drain line extended to drain for strainers of 4" size and larger.

EXECUTION

METHOD OF INSTALLATION

Ream pipes and tubes. Clean off scale and dirt, inside and outside before assembly. Remove welding slag or other foreign material from piping. During construction, until system is fully operational, keep all openings in piping and equipment closed except when actual work is being performed on that item or system. Provide closures, plugs, caps, blind flanges or other similar items specifically designed for this purpose.

Run pipe lines straight and true, parallel to building lines with minimum use of offsets and couplings. Provide offsets only to provide headroom or clearance and to provide flexibility in pipe lines. Changes in direction of pipe lines made only with fittings or pipe bends. Changes in size made only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. All fittings of long radius type, unless otherwise indicated. Use full and double lengths of pipe wherever possible.

Cut pipe to exact measurement and install without springing or forcing except in case of expansion loops where cold springing is indicated. Take particular care to avoid creating, even temporarily, undue loads, forces or strains on valves, equipment or building elements with piping connections or piping supports.

Install piping to allow for expansion and contraction without stressing pipe or equipment connected.

Provide clearance for installation of insulation and for access to valves, air vents, drains and unions.

Unions and flanges for servicing and disconnect are not required in installations using grooved joint couplings. (The couplings shall serve as disconnect points.)

Final connections to all equipment and fixtures shall be made in a manner that will permit the complete removal of any fixtures or any piece of equipment without cutting pipe lines.

Use main sized saddle type branch connections or directly connecting branch lines to mains in steel piping if main is at least one pipe size larger than branch for up to 6" mains; and if main is at least two pipe sizes larger than branch for 8" and larger mains. Do not project branch pipes inside main pipe.

Provide flanges or unions at all final connections to equipment, traps and valves to facilitate dismantling. Arrange piping and piping connections so that equipment being served may be serviced or totally removed without disturbing piping beyond final connections and associated shut-off valves.

Grooved joint shall be installed in accordance with the manufacturer's written recommendations. Grooved ends shall be clean and free from indentations, projections, or roll marks. The gasket shall be molded and produced by the coupling manufacturer of an elastomer suitable for the intended service. The coupling manufacturer's factory trained representative shall provide on-site training for the contractor's field personnel in the use of grooving tools and installation of product. The representative shall periodically visit the job site to ensure best practices in grooved product installation are being followed. (A distributor's representative is not considered qualified to conduct the training.)

Threaded joints shall be full and clean cut. Joints shall be made up tight with joint compound or Teflon joint tape manufactured and approved for use with the contents to flow within the pipe and exposed threads of ferrous pipe shall be painted with acid-resisting paint after piping has been tested and proved tight. No caulking, lampwick, or other material shall be used for correction of defective joints.

Flanged joints shall be steel pipe flanges: ANSI B16.5. Steel flanges shall have raised-face, except when bolted to flat-face cast-iron flange. Bolting for services up to 500°F: ASTM A307, Grade B, with square head bolts and heavy hexagonal nuts conforming to ANSI B18.2.1 and B18.2.2. Set flange bolts beyond finger tightness with indicating torque wrench to ensure equal tension in all bolts. Tighten bolts such that those 180° apart or directly opposite are torqued in sequence.

Water piping shall be pitched to drain at low points. Steel to copper connections shall be made with dielectric unions.

Expansion joints or expansion loops and offsets shall be installed where shown on plans and where necessary to provide for expansion of piping.

For water systems, Victaulic flexible couplings may be used on header piping to accommodate thermal growth and contraction, and for the elimination of expansion loops (as approved by the engineer). Where loops are required, use flexible-type couplings on the loops.

Weld pipe joints in accordance with ANSI B31. Qualify welding procedures, welders and operators in accordance with ANSI B31.1, paragraph 127.5 for shop and project site welding of piping work. Weld pipe joints in accordance with recognized industry practice. Bevel pipe ends at 37.5° angle where possible, smooth rough cuts and clean to remove slag, metal particles and dirt. Install welding rings for butt-welded joints. Use pipe clamps or tack-weld joints with 12" long welds. Use four welds for pipe sizes up to 10", or use eight welds for pipe sizes 12" through 20". Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes and non- metallic inclusions. Do not weld-out piping system imperfections by tack-welding procedures; re-fabricate to comply with requirements. Install forged branch-connection fittings wherever branch pipe is indicated.

Chilled water piping and hot water heating piping shall be downgraded to drain connections at low points and shall be upgraded to vent connections at high points. Vent connections shall be provided with manual air vent cocks and copper tube "pigtails" to facilitate catching water, except automatic vent valves shall be furnished and installed where indicated on drawings and drain lines shall be extended from automatic vent valves and ended over drains.

Drain piping for coil drain pans shall extend full size of pan outlet, or minimum of ¾". Use plugs on all joints with crosses. Provide trap on drain pan outlets on air systems to prevent blowing through trap. Extend drain line to open waste over floor drains.

INSPECTION

The inside and outside surfaces of all pipe, tubing, valves, and fittings shall be cleaned of all dirt, sand, loose mill scale, and other foreign materials immediately after removal from storage and before erection. After completion of all piping systems, all lines shall be thoroughly flushed or blown out before being placed in service. The Contractor shall notify the Owner prior to starting any post erecting cleaning operation in sufficient time to allow witnessing the operation. Prior to blowing or flushing erected piping systems, the Contractor shall disconnect all instrumentation and equipment, fully open all valves, and ensure that all strainer screens are in place.

Pipe and components on water systems shall be flushed with clean water until all discharge from the system is clean. A water sample from each system shall be analyzed for cleanliness after system is flushed with clean water. If the water analysis indicates that the system is not clean, the system shall be flushed with a precleaning chemical designed to remove oil, pipe dope, loose mill scale, and other extraneous materials. The Contractor shall submit to the Engineer the proposed precleaning chemicals for approval. This cleaning shall be followed by water flushing as described. Minimum velocities of 5 feet/second shall be maintained at all points. Flow shall be in same direction as when the system is in normal operation. Discharge shall be from low points of lines, ends or headers, and as otherwise required to flush the entire system. After flushing, any residual water shall be drained and/or blown out prior to testing.

TESTING

All hydraulic and pneumatic testing shall conform to ANSI B31.1, B31.5, B31.8 and B31.9. The Contractor shall apply the specified test pressure for a minimum time at least equal to the applicable standard's requirements.

Perform tests only after the pipe and contents have stabilized at ambient temperature and the source of test pressure is shut off. Piping tests shall apply to piping only, with all equipment, and instruments blocked off or disconnected. No component or piping shall be subjected to pressures which exceed their respective pressure ratings. Provide temporary restraints on expansion joints and flexible connections during pressure testing.

Hydrostatic and pneumatic tests shall apply to piping as shown on the following schedule. The pressure shall be gradually raised to the value specified and the source then blocked off. Leakage or loss of pressure in the test duration period shall not be acceptable unless otherwise noted.

PIPING TEST

Service	Hydro Working Press. (psig)	Test Press. (psig)	Pneumatic Working Press. (psig)	Test Press. (psig)	Test Period Hours
Chilled Water	10-175	100			2

Heating Water	10-175	100			2
Condenser Water	10-175	100			2

Audible or visible procedure at no additional cost to the Owner.

Upon successful completion Contractor shall visually examine all joints during the tests. and approval of the tests, the Contractor shall relieve leaks detected during testing shall be cause to disapprove the test even though the maximum allowable pressure drop has not been exceeded. The Contractor shall repair all leaks and shall repeat the complete testing the piping of pressure, drain the system, and put the system into normal operation after further complying with all cleaning requirements as specified.

end of section 232113

SECTION 232116 – HYDRONIC SPECIALTIES

GENERAL

DESCRIPTION OF WORK

Air and Dirt Separators for Closed Systems

Automatic Flow Control Valves

Balancing Valves

Flow Measuring and Transmitting Stations

Air Vent Valves (Hydronic Systems)

Pressure and Temperature Test Plugs

Pressure Regulating Valves

Expansion Tanks

"Y" Type Strainers

Thermal Storage (Buffer) Tanks

QUALITY ASSURANCE

Manufacturer's Qualifications:

1. *Firms regularly engaged in the manufacture of equipment specified within this section of types and capacities required, whose products have been in satisfactory use in similar service for a minimum of 5 years.*

SUBMITTALS

Submit in accordance with Division 1.

Product Data:

Submit manufacturer's catalog cut sheets, specifications, installation instructions, and dimensioned drawings for each type of manufactured hydronic specialty.

Include a pressure drop curve or chart for each type and size of hydronic specialty.

Submit a schedule showing manufacturer's model number, size, location, rated capacities, and features for each hydronic specialty.

PRODUCTS

AIR & DIRT SEPARATORS FOR CLOSED SYSTEMS

Air and Dirt Separators shall be coalescing type air eliminator and dirt separator on the heating and chilled water systems. All combination units shall be fabricated steel, rated for 150 psig working pressure with entering velocities not to exceed 4 feet per second at specified GPM. Units specifically designed for high velocity systems may have an entering velocity of up to 10 feet per second.

Units shall include an internal bundle filling the entire vessel to suppress turbulence and provide high efficiency. The bundle must consist of a copper core tube with continuous wound copper medium permanently affixed to the core. A separate copper medium is to be wound completely around and permanently affixed to the internal element. Each eliminator shall have a separate venting chamber to prevent system contaminant from harming the float and venting valve operation. At the top of the venting chamber shall be an integral full port float actuated brass venting mechanism.

Units shall include a valve side tap to flush floating dirt and liquid and for quick bleeding of large amounts of air during system fill or refill. Separator shall have the vessel extended below the pipe connection an equal distance for dirt separation.

Air eliminators shall be capable of removing 100% of the free air, 100% of the entrained air and up to 99.6% of the dissolved air in the system fluid. Dirt separator shall remove at least 80% of all particle 30 micron and larger within 100 passes.

Manufacturer

Spirotherm
Armstrong

AUTOMATIC FLOW CONTROL VALVES

Provide automatic flow control valves where shown on plans or where required for system balancing.

Valves used for flow control (balancing) of water in hydronic systems shall be factory set and shall automatically limit the rate of flow to within ±5% of the specified amount. An integral Viton O-rings union shall provide access for regulator change-out, inspection and cleaning.

Valves 2½" and larger shall have flanged connections. Valves 2" and smaller shall have NPT threaded connections.

Valves shall be installed with ports pointing upward and at an angle not greater 45 degrees from vertical. The balancing valve shall be located for convenient use and viewing.

Material:

All internal parts of the valve shall be either hard electroless nickel plated or stainless steel. Body shall be brass rated at 400 psi, 275°.

Accessories:

Balancing valve shall have a hidden memory feature to program valve with precision tamper-proof balancing setting. Valves shall be furnished with dual pressure/temperature test ports with leak-tight threaded caps for installation with 1 1/2" insulation. Each valve shall be furnished with a factory pre-molded two-piece insulating cover that is removable and that will seal-off vapor tight when installed on the valve.

Provide a differential pressure test kit. The kit shall consist of a 4 1/2" diaphragm gauge equipped with ten foot hoses and P/T adapters all housed in a vinyl case. Calibration shall be 0-35 PSID for 2-32 PSI spring range or 0-65 PSID for 5-60 PSI range.

Manufacturers:

AutoFlow: Model UR Series

Griswald

BALANCING VALVES

Provide balancing valves where shown on plans or where required for system balancing. Valves used for flow control (balancing) of water in hydronic systems shall be globe style design. Unless otherwise noted, balancing valves shall be rated for not less than 125 psi at 250°F. Valves 2½" and larger shall have flanged connections. Valves 2" and smaller shall have NPT threaded connections.

After the final balancing of the system is approved by the Engineer, each valve balance setpoint shall be permanently marked on the register so as to be clearly visible. Valves shall be installed with meter connections pointing upward and at an angle not greater 45 degrees from vertical. Indicator pointer shall not be above the horizontal. The balancing valve shall be located for convenient use and viewing.

Balancing valve shall have a hidden memory feature to program valve with precision tamper-proof balancing setting. Balancing valves shall be furnished with dual pressure/temperature test ports with leak-tight threaded caps and built-in check valves or cut-off cocks. Valves shall have ¾" NPT drain hose socket with drain cap. Each valve shall be furnished with a factory pre-molded two-piece insulating cover that is removable and that will seal-off vapor tight when installed on the valve.

Furnish and install, as shown on plans and in accordance to manufacturer's installation instructions Each valve shall have two ¼ NPT brass metering ports with check valves and gasketted caps located on both sides of valve seat. Two additional 1/4 NPT connections with brass plugs are to be provided on the opposite side of the metering ports for use as drain connections. Drain connections and metering ports are to be interchangeable to allow for measurement flexibility when valves are installed in tight locations.

Valve shall provide multi-turn, 360° adjustment with a micrometer type indicator located on valve handwheel. Valve handwheel shall have hidden memory feature, which will provide a means for locking the valve position after the system is balanced. 90° turn adjustable valves are not acceptable.

Material:

Valves shall be of nonferrous copper alloy or cast iron construction with nonferrous copper alloy trim.

The valve shall be installed with flow in the direction of the arrow on the valve body and installed at least five pipe diameters downstream from any fitting, and at least ten pipe diameters downstream from any pump. Two pipe diameters downstream from the balance valve shall be free of any fittings. Install for unobstructed access to the valve handwheel and metering ports for adjustment and measurement. Mounting of valve in piping must prevent sediment build-up in metering ports.

Each valve shall be furnished with a pre-formed removable PVC insulation jacket to meet ASTM D 1784/class 14253-C, MEA#7-87, ASTM-E-84 and ASTM-136 with a flame spread rating of 50 or less. There will be provided sufficient mineral fiberglass insulation to meet ASHRAE 90.1-1989 specifications in operating conditions with maximum Fluid Design Operating Temperature Range of 141-200°F and Mean Rating Temperature of 125°F.

Manufacturers:

Nibco
Armstrong
Tour & Anderson
Victaulic

FLOW MEASURING AND TRANSMITTING STATIONS

Flow meters for liquid service shall be of the insertion type turbine meter with an electromagnetic sensor generating a 2-12 Vdc square wave pulse. Insertion length shall be according to manufacturer's recommendations.

Turndown shall be 10:1 with a flow rate range as indicated on the Equipment Schedule. Linearity shall be ±1% over operating range and repeatability shall be ±0.25%.

Material: Construction shall be of stainless steel for all wetted parts. Rotor bearing shall be made of long wearing low-friction material. Turbine meter shall be insulated according to manufacturer's instructions.

Process connection shall be 150 lb. flange fitting with full port isolation ball valve. Flow element assembly shall be furnished complete with extraction assembly equipment which shall allow removal of the flow element from the process line without interruption of service.

Flow meter shall be furnished complete with mounted remote panel, 6-digit electro-mechanical indicator/totalizer with manual reset and a 4-20 mA output.

Furnish all necessary devices and connections for interfacing each meter assembly with the Building Automation System (BAS). Reference Division 17 transmitter and BAS specification

Manufacturers:

EMCO

Rosemount

AIR VENT VALVES (HYDRONIC SYSTEMS)

General:

Provide air vent valves in water systems at all high points and at all locations as required to prevent the accumulation of air in the system. Vent valves shall be manual key type except where shown on drawings to be automatic. Manual and automatic air vent valves shall be rated for water working pressure of not less than 250 psi.

Material:

Vent valves shall be all brass with copper tube pig-tail. Turn pig-tail downward for manual vent valves.

Accessories:

Extend drain line from automatic vent valves to floor drain. Install vent valve in locations to be accessible without requiring removal of equipment or cabinets.

PRESSURE AND TEMPERATURE TEST PLUGS

General:

Provide capped test plugs in piping systems in all locations where testing and balancing is required and where shown on drawings. At a minimum test plugs shall be provided in piping system wherever there is a change in temperature or pressure due to installed equipment. This includes but not limited to heat exchangers, coils chillers, boilers and pumps. Provide test plugs on both the inlet and outlet of the equipment.

Provide test plugs for all differential pressure transmitters for that pressure difference can be measured without the removal of piping.

Plugs shall be installed in accordance with the manufacturer's recommendations, including approach and depart distances from pipe fittings, valves, etc.

Material:

Plug shall have a ¼" NPT brass fitting with Nordel valve core seals rated up to 1000 psi at -40°F and 275°F and shall allow insertion of a pressure or temperature probe while the pipe or equipment is under pressure. Each plug fitting shall have a threaded brass cap.

Accessories:

Provide a ball valve upstream of each plug for servicing.

PRESSURE REGULATING VALVES

Material:

Water pressure regulating valves for make-up water connections to heating or cooling systems shall be adjustable type, of bronze construction with replaceable nickel alloy seat and integral stainless steel strainer. Install pressure gauge on discharge side of valve.

Manufacturers:

Watts: #135
Cash
McDonnell

EXPANSION TANK

Material:

Expansion tank for chilled and hot water systems shall be captive type expansion tank with steel shell, heavy duty elastomeric diaphragm (bladder), piping connections, air charge, and ASME rated construction for 100 psi working pressure.

Accessories:

Expansion tanks shall be complete with automatic fill and makeup water control valve with removable strainer, air purger fitting with inlet and outlet water connections, and automatic air vent valve complete with connector for extending vent line to drain. Tank shall be pressure charged as required by system. Extend vent piping from automatic vent valve and connect to condensate drain pipe above ceiling.

Manufacturers:

Bell & Gossett

Armstrong
Amtrol

"Y" TYPE STRAINERS

Material:

Strainer body shall be bronze or carbon steel with stainless steel screen. Screen size shall be selected for application.

Accessories:

Provide strainers 2½" and larger with off center blowdown to allow for near complete cleanout. Provide a shutoff valve on the blowdown and extend a blowdown line to the nearest floor drain. Provide a ball valve upstream of all strainers for servicing. Unless otherwise noted, strainers shall be rated for not less than 125 psi at 250°F. Strainers 2½" and larger shall have flanged connections; 2" and smaller shall have NPT threaded connections.

Manufacturers:

Armstrong

execution

Provide and install hydronic specialties as shown on drawings and specified above.

Specialties shall be installed in accordance with manufacturers written instructions.

Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.

Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

Install in-line air separators in pump suction. Install drain valve on air separators 2" and larger, and pipe to discharge to nearest floor drain with air gap.

Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual air vent for initial fill to establish proper water level in tank.

Install tank fittings that are shipped loose.

Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

END OF SECTION 232116

SECTION 232123 – MECHANICAL PUMPS

GENERAL

DESCRIPTION OF WORK:

Base mounted end suction pumps

In-Line circulating pumps

QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in the manufacture of equipment specified within this section of types and capacities required, whose products have been in satisfactory use in similar service for a minimum of 5 years.

SUBMITTALS:

Submit in accordance with Division 1, Section 01300.

Product Data:

Submit manufacturer certified pump curves showing pump performance characteristics with pump and system operating point plotted.

Shop Drawings:

Submit detailed shop drawings indicating all control and power connections for complete system operation.

products

BASE MOUNTED END SUCTION PUMPS

Material:

Pump shall be base-mounted type, of bronze fitted construction with machined brass or bronze impeller, steel shaft, leak-proof mechanical seals, bronze or copper shaft sleeve, cast iron casing, designed and rated for not less than 175 psi.

Pumps shall be installed with adequate supports so that strain, vibration, and noise transmission of connecting piping and supports is eliminated.

Each pump shall be furnished with capacity, operating head and horsepower not less than shown on drawings. Voltage characteristics shall be as scheduled on drawings. Motor shall not overload under any change in operating head.

Manufacturers:

Aurora

Bell & Gossett

Armstrong

Taco

Grundfos

IN LINE PUMPS

Material:

Pump shall be in-line type, of bronze fitted construction with machined brass or bronze impeller, steel shaft, leak-proof mechanical seals, flexible coupling drive, drive guard, bronze or copper shaft sleeve, cast iron casing, designed and rated for not less than 175 psi and 225°F. Provide motor with thermal overload protection. Model number, capacity, operating head, minimum horsepower, and voltage characteristics shall be as shown on drawings.

Pumps shall be installed with adequate supports so that strain, vibration, and noise transmission through piping and supports is eliminated. Furnish with motor controls as shown on drawings.

Each pump shall be furnished with capacity, operating head and horsepower not less than shown on drawings. Voltage characteristics shall be as scheduled on drawings. Motor shall not overload under any change in operating head.

Manufacturers:

Aurora

Bell & Gossett

Thrush

Taco

Grundfos

EXECUTION

METHOD OF INSTALLATION

Pumps shall be provided complete with mounting brackets, motor supports, couplings, mechanical seals, and motors. Pump hydraulic characteristics shall be as scheduled on the drawings. Pumps shall have a minimum operating efficiency as scheduled on drawings at the design flow conditions.

Pumps shall have statically and dynamically balanced rotating parts. Pumps shall allow for complete servicing without breaking piping or motor connections. All pumps shall operate at 1750 RPM unless specified or scheduled otherwise.

END OF SECTION

SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig.
2. Hot-Gas and Liquid Lines: 535 psig.

1.4 SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:

1. Thermostatic expansion valves.
2. Solenoid valves.
3. Hot-gas bypass valves.
4. Filter dryers.
5. Strainers.
6. Moisture Indicating Sight Glass.
7. Pressure-regulating valves.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.

1. Shop Drawing Scale: 1/4 inch equals 1 foot.
2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

C. Welding certificates.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.6 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 280, Type ACR.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8.

F. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250° F.

2.2 VALVES AND SPECIALTIES

A. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

B. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.

5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240° F.
8. Manual operator.

C. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
2. Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Seat Disc: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Working Pressure Rating: 400 psig.
6. Maximum Operating Temperature: 240° F.

D. Thermostatic Expansion Valves: Comply with ARI 750.

1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: Per Condensing Unit Schedule.
6. Superheat: Adjustable.
7. End Connections: Socket, flare, or threaded union.
8. Working Pressure Rating: 450 psig.

E. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.

1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
5. Seat: Polytetrafluoroethylene.
6. Equalizer: Internal.
7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.
8. End Connections: Socket.
9. Set Pressure: Per Condensing Unit Manufacturer Requirements.
10. Throttling Range: Maximum 5 psig.
11. Working Pressure Rating: 500 psig.
12. Maximum Operating Temperature: 240° F.

F. Angle-Type Strainers:

1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275° F.

G. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240° F.

H. Replaceable-Core Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated charcoal.
4. Designed for reverse flow (for heat-pump applications).

5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Rated Flow: Per Condensing Unit Schedule.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240° F.

I. Receivers: Comply with ARI 495.

1. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
2. Comply with UL 207; listed and labeled by an NRTL.
3. Body: Welded steel with corrosion-resistant coating.
4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
5. End Connections: Socket or threaded.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275° F.

2.3 REFRIGERANTS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Atofina Chemicals, Inc.
2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants.
4. INEOS Fluor Americas LLC.

C. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

B. Hot-Gas and Liquid Lines: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

C. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless valves in suction and discharge lines of compressor.

B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

E. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

F. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

G. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

H. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:

1. Solenoid valves.
2. Thermostatic expansion valves.
3. Compressor.

I. Install filter dryers in liquid line between compressor and thermostatic expansion valve.

J. Install receivers sized to accommodate pump-down charge.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Refer to Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operation" for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access

doors or panels as specified in Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in protective conduit where installed belowground.

N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

Q. Install pipe sleeves at penetrations in exterior walls and floor assemblies.

R. Seal penetrations through fire and smoke barriers according to Division 07 Section "Penetration Firestopping."

S. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

T. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

U. Seal pipe penetrations through exterior walls according to Division 07 Section "Joint Sealants" for materials and methods.

V. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
    a. Fill system with nitrogen to the required test pressure.
    b. System shall maintain test pressure at the manifold gage throughout duration of test.
    c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    d. Remake leaking joints using new materials and retest until satisfactory results are achieved.

3.6 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.7 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

SECTION 23 23 15 - REFRIGERATION SPECIALTIES

GENERAL

DESCRIPTION OF WORK

Liquid indicators

Sight glasses

Strainers

Refrigerant dryers

Filter-dryers

Solenoid valves

Expansion valves

Relief valves

Charging valves

Suction pressure regulator

Receivers

Flexible connections

RELATED DOCUMENTS

Section 230050: Basic Mechanical Materials and Methods

American National Standards Institute, ANSI:

B31.5: Refrigeration Piping.

Extend specified lower pressure limits to pressures below 15 psig.

Safety Code Compliance: Comply with portions of ANSI B9.1, "Safety Code for Mechanical Refrigeration".

QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in the manufacture of equipment specified within this section of types and capacities required, whose products have been in satisfactory use in similar service for a minimum of 5 years.

SUBMITTALS

Submit in accordance with Division 1, Section 01300.

Product Data:

Submit catalog cuts, specifications, installation instructions, and dimensioned drawings for each steam specialty.

Submit schedule showing manufacturer's figure number, size, location, rated capacities, and features for each steam specialty.

products

LIQUID INDICATORS

Material: Liquid indicators shall be double port type with copper or brass body, and flared or solder ends.

Accessories: Provide removable seal caps on each port for inspection or refrigerant condition.

Manufacturers:

Hersey Products, Inc.

Mueller Company

Studebaker-Worthington, Inc.

SIGHT GLASSES

Material: Refrigerant moisture and liquid sight glasses shall be designed for minimum 450 psig safe working pressure, with socket type end connections

Manufacturers:

Alco Controls Corp.: AMI Services

Henry Valve Co.: Dri-Vue

Mueller Brass Co.: Sightmaster

Sporlan Valve Co.: See All

STRAINERS

Material: Strainers shall be angle type with brass shell and replaceable cartridge. Strainers shall be suitable for refrigerant and piping material used in system.

Manufacturers:

Mueller Brass Co.

Wylain, Inc.

Zurn Industries, Inc.

EXPANSION VALVES

Material:

Valve body shall be brass. Valves shall be thermostatic type, with internal or external equalizer and adjustable superheat setting. Valve shall be complete with capillary tube and remote sensing bulb.

Expansion valves shall be sized for full load, but shall not be excessively oversized at partial load. Valve shall be selected for maximum load at design operating pressure and minimum 43°F of superheat.

Evaluate refrigerant pressure drop through system to determine available pressure drop across each valve.

Maximum Safe Working Pressure: 300 psig.

Manufacturers:

Alco Controls Corp.

Controls Company of America

Sporlan Valve Co.

RELIEF VALVES

Material:

Relief valves shall be constructed and stamped in accordance with ASME specifications and bear symbol NB certification as to capacities. All refrigerant relief valves shall be sized in accordance with ANSI B9.1, designed for safe working pressure of 500 psi, minimum.

Accessories:

Valves shall be provided with male pipe threaded connection on inlet, and flare tubing connection on outlet. Provide chained seal cap provided over charging opening.

Manufactures:

Henry Valve Co.: Type 52 or 53
Herotest Mfg. Corp.: R-40, R-51, R-62
Mueller Brass Co.: Safetymaster

SUCTION PRESSURE REGULATOR

Material:

Regulators shall have size and capacity to suit refrigerant and maximum coil loads specified, with minimum 200 psig safe working pressure, and oval flange type copper tube connections.

Accessories:

Where indicated, valves shall be provided with remote temperature pilot/remote pressure pilot. Pilot lines shall be provided with strainer as recommended by valve manufacturer.

Manufactures:

Alco Controls Corp.: EPR Series
Controls Co. of America: Model 239
Hubbell Corp..: SF Series

RECEIVERS

Material: Receivers shall be constructed in accordance with ASME Boiler Construction Code, stamped certifying 450 psig working pressure minimum. Receivers shall be dehydrated, charged with an inert gas, and sealed prior to shipment. Charge shall not be released until piping is connected.

Accessories: Receivers shall be provided with liquid inlet and outlet valves, relief valves, purge valves, magnetic liquid level indicator and mounting brackets. Welding, including brackets and accessories, shall be completed in manufacturer's shop prior to shop testing and ASME stamp application.

Manufacturers:

Acme Industries, Inc.
Carrier Air Conditioning Co.
Trane Co.

FLEXIBLE CONNECTIONS

Material:

Flexible connections shall be close pitched corrugated bronze hose with single layer of exterior braiding. Flexible connections shall be at least 9 inches long with bronze fittings. Flexible connections shall have socket type end connections.

Manufacturers:

American Brass Company: Vibration Eliminator
Atlantic-Metal Hose Co., Inc.: Vibraducer
Metraflex Company: Type LFF
Universal Air Products: Vibra-Sorbers
Universal Metal Hose Co.: Type UV-F

EXECUTION

METHOD OF INSTALLATION

Install refrigeration specialties in accordance with manufacturer's instruction.

Liquid Indicators:

Locate full-size liquid indicators in main liquid line leaving condenser.
When a receiver is used in the system, install indicator in the liquid line leaving the receiver.

Strainers:

Locate full-size strainer ahead of each automatic valve.
Where multiple expansion valves with integral strainers are used, install single main liquid line strainer.
On steel piping systems, provide strainer in suction line to remove scale and rust.
Install shut-off valve on each side of strainer to facilitate maintenance.

Sight Glass:

Install on all liquid and suction lines to heat recovery units.

Refrigerant Isolation Valves:

Install on all liquid and suction lines to heat recovery units.

Solenoid Valves:

Locate solenoid valves in liquid line of systems operating with single pump-out or pump-down compressor control, in liquid line of single or multiple evaporator systems, and in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into suction line when system shuts down.

Unions:

Install on all liquid and suction lines to indoor units and outdoor condenser unit connections.

Temperature and Pressure ports

Install on all liquid, hot gas and suction lines to heat recovery boxes unit and outdoor condenser unit piping.

Strainer

Install prior to suction connection to indoor units only.

Flexible Connections:

Use only at or near compressors where it is not physically possible to absorb vibration within piping configuration.

Do not install any on this project.

END OF SECTION 232315

PART 1. GENERAL

1.1 DESCRIPTION OF WORK

A. This section specifies cleaning and treatment of circulating HVAC water systems, including the following.

1) Cleaning compounds.

2) Chemical treatment for closed loop heat transfer systems (chilled and hot water).

3) Chemical treatment for open loop systems.

4) Glycol-water heat transfer systems.

5) Chemical Pot feeder (where required to be installed).

B. The contractor shall be responsible for the initial treatment for water systems during drain-down or initial fill charging. No extras will be paid for filling and treating of systems.

1.2 RELATED DOCUMENTS

A. Test requirements and instructions on use of equipment/system: Section 230500, GENERAL PROVISIONS.

B. General mechanical requirements and items, which are common to more than one section of Division 15: Section 15990, TESTING BALANCING AND START-UP.

C. Piping and valves: Section 231100, HAVAC PIPING and section 230523. HVAC VALVES.

1.3 QUALITY ASSURANCE

A. Technical Services: Provide the services of an experienced water treatment chemical engineer or technical representative to direct flushing, cleaning, pre-treatment, training, debugging, and acceptance testing operations; direct and perform chemical limit control during construction period and monitor systems for a period of 12 months after acceptance, including not less than 4 service calls and written status reports. During this period perform monthly tests of the closed circuit evaporative coolers for Legionella pneumophila and submit reports stating Legionella bacteria count per millimeter. These tests shall be conducted in a certified laboratory and not by a technician in the field. Minimum service during construction/start-up shall be 4 hours.

C. Field Quality Control and Certified Laboratory Reports: During the one year guarantee period, the water treatment laboratory shall provide not less than 12 reports based on on-site periodic visits, as stated in paragraph 1.3.B, sample taking and testing, and review with VA personnel, of water treatment control for the previous period. In addition to field tests, the water treatment laboratory shall provide certified laboratory test reports. These monitoring reports shall assess chemical treatment accuracy, scale formation, fouling and corrosion control, and shall contain instructions for the correction of any out-of-control condition.

D. Log Forms: Provide one year supply of preprinted water treatment test log forms.

1.4 SUBMITTALS

A. Shop drawings, project data and samples furnished by the manufacturer shall illustrate materials, equipment or workmanship, and establish standards by which the work will be judged. Submit in accordance with Division 1, Section 01300.

B. Manufacturer's Literature and Data:

1) Cleaning compounds and recommended procedures for their use.

2) Chemical treatment for closed systems, including installation and operating instructions.

3) Chemical treatment for open loop systems, including installation and operating instructions.

4) Glycol-water system materials, equipment, and installation.

C. Water analysis verification.

D. Materials Safety Data Sheet for all proposed chemical compounds, based on U.S. Department of Labor Form No. L5B-005-4.

PART 2. EQUIPMENT

2.1 CLEANING COMPOUNDS

A. Alkaline phosphate or non-phosphate detergent/surfactant/specific to remove organic soil, hydrocarbons, flux, pipe mill varnish, pipe compounds, iron oxide, and like deleterious substances, with or without inhibitor, suitable for system wetted metals without deleterious effects.

B. Refer to Section 15050, HVAC PIPING SYSTEMS, PART 3, for flushing and cleaning procedures.

2.2 CHEMICAL TREATMENT FOR CLOSED LOOP SYSTEMS

A. Inhibitor: Provide sodium nitrite/borate, molybdate-based inhibitor or other approved compound suitable for make-up quality and make-up rate and which will cause or enhance bacteria/corrosion problems or mechanical seal failure due to excessive total dissolved solids. Shot feed manually. Maintain inhibitor residual as determined by water treatment laboratory, taking into consideration residual and temperature effect on pump mechanical seals.

B. pH Control: Inhibitor formulation shall include adequate buffer to maintain pH range of 8.0 to 10.5.

C. Performance: Protect various wetted, coupled, materials of construction including ferrous, and red and yellow metals. Maintain system essentially free of scale, corrosion, and fouling. Corrosion rate of following metals shall not exceed specified mills per year penetration; ferrous, 0-2; brass, 0-1; copper, 0-1. Inhibitor shall be stable at equipment skin surface temperatures and bulk water temperatures of not less than 121 degrees C (250 degrees F) and 52 degrees C (125 degrees Fahrenheit) respectively. Heat exchanger fouling and capacity reduction shall not exceed that allowed by fouling factor 0.0005.

D. Pot Feeder: By-pass type, complete with necessary shut off valves, drain and air release valves, and system connections, for introducing chemicals into system, cast iron or steel tank with funnel or large opening on top for easy chemical addition. Feeders shall be 18.9 L (five gallon) minimum capacity at 860 kPa (125 psig) minimum working pressure.

E. Side stream Water Filter for Closed Loop Systems: Stainless steel housing, and polypropylene filter media with // polypropylene // stainless steel // core. Filter media shall be compatible with antifreeze and water treatment chemicals used in the system. Replaceable filter cartridges for sediment removal service with minimum 20 micrometer particulate at 98 percent efficiency for approximately five (5) percent of system design flow rate. Filter cartridge shall have a maximum pressure drop of 13.8 kPa (2 psig) at design flow rate when clean, and maximum pressure drop of 172 kPa (25 psig) when dirty. A constant flow rate valve shall be provided in the piping to the filter. Inlet and outlet pressure gauges shall be provided to monitor filter condition.

2.3 GLYCOL FILL AND MAKE-UP SYSTEM (MANUAL)

A. Refer to Hydronic Specialities section in Division 23.

PART 3. EXECUTION

3.1 INSTALLATION

A. Delivery and Storage: Deliver all chemicals in manufacturer's sealed shipping containers. Store in designated space and protect from deleterious exposure and hazardous spills.

B. Install equipment furnished by the chemical treatment supplier and charge systems according to the manufacturer's instructions and as directed by the Technical Representative.

C. Before adding cleaning chemical to the closed systems, all air handling coils and fan coil units should be isolated by closing the inlet and outlet valves and opening the bypass valves. This is done to prevent dirt and solids from lodging the coils. Provide additional valves and connections as necessary to properly isolate, flush and clean new pieces of piping and equipment in the existing systems and new systems.

D. After chemical cleaning is satisfactorily completed, open the inlet and outlet valves to each coil and close the by-pass valves. Also, clean all strainers.

END OF SECTION

SECTION 232500 - WATER TREATMENT (MECHANICAL PIPING)

PART 1. GENERAL

1.1 DESCRIPTION OF WORK

A. This section specifies cleaning and treatment of circulating HVAC water systems, including the following.

1. Cleaning Compounds.
2. Chemical Treatment for Closed Loop Heat Transfer Systems.
3. Chemical Feeder (Manual Pot Type).

B. The contractor shall be responsible for the initial treatment for chilled, hot, and condenser water systems during drain-down or initial fill charging. No extras will be paid for filling and treating of systems.

1.2 RELATED DOCUMENTS

A. Test requirements and instructions on use of equipment/system: Section 230500, GENERAL PROVISIONS.

B. General mechanical requirements and items, which are common to more than one section of Division 15: Section 230593, TESTING BALANCING AND START-UP.

C. Piping and valves: Section 231100, HVAC PIPING and section 230523. HVAC VALVES.

1.3 QUALITY ASSURANCE

A. Refer to, FINAL CLEANING CONTROL in Section 01710.

B. Technical Services: Provide the services of an experienced water treatment chemical engineer or technical representative to direct flushing, cleaning, pre-treatment, training, debugging, and acceptance testing operations; direct and perform chemical limit control during construction period and monitor systems for a period of 12 months after acceptance, including not less than 4 service calls and written status reports. During this period perform monthly tests of the closed circuit evaporative coolers for Legionella pneumophila and submit reports stating Legionella bacteria count per millimeter. These tests shall be conducted in a certified laboratory and not by a technician in the field. Minimum service during construction/start-up shall be 4 hours.

C. Field Quality Control and Certified Laboratory Reports: During the one year guarantee period, the water treatment laboratory shall provide not less than 12 reports based on on-site periodic visits, as stated in paragraph 1.3.B, sample taking and testing, and review with VA personnel, of water treatment control for the previous period. In addition to field tests, the water treatment laboratory shall provide certified laboratory test reports. These monitoring reports shall assess chemical treatment accuracy, scale formation, fouling and corrosion control, and shall contain instructions for the correction of any out-of-control condition.

D. Log Forms: Provide one year supply of preprinted water treatment test log forms.

1.4 SUBMITTALS

A. Shop drawings, project data and samples furnished by the manufacturer shall illustrate materials, equipment or workmanship, and establish standards by which the work will be judged. Submit in accordance with Division 1, Section 01300.

B. Manufacturer's Literature and Data:

1. Cleaning compounds and recommended procedures for their use.
2. Chemical treatment for closed systems, including installation and operating instructions.
3. Chemical treatment for open loop systems, including installation and operating instructions.
4. Glycol-water system materials, equipment, and installation.

C. Water analysis verification.

D. Materials Safety Data Sheet for all proposed chemical compounds, based on U.S. Department of Labor Form No. L5B-005-4.

PART 2. EQUIPMENT

2.1 CLEANING COMPOUNDS

A. Alkaline phosphate or non-phosphate detergent/surfactant/specific to remove organic soil, hydrocarbons, flux, pipe mill varnish, pipe compounds, iron oxide, and like deleterious substances, with or without inhibitor, suitable for system wetted metals without deleterious effects.

B. Refer to Section 231100, HVAC PIPING SYSTEMS, PART 3, for flushing and cleaning procedures.

2.2 CHEMICAL TREATMENT FOR CLOSED LOOP SYSTEMS

A. Inhibitor: Provide sodium nitrite/borate, molybdate-based inhibitor or other approved compound suitable for make-up quality and make-up rate and which will cause or enhance bacteria/corrosion problems or mechanical seal failure due to excessive total dissolved solids. Shot feed manually. Maintain inhibitor residual as determined by water treatment laboratory, taking into consideration residual and temperature effect on pump mechanical seals.

B. pH Control: Inhibitor formulation shall include adequate buffer to maintain pH range of 8.0 to 10.5.

C. Performance: Protect various wetted, coupled, materials of construction including ferrous, and red and yellow metals. Maintain system essentially free of scale, corrosion, and fouling. Corrosion rate of following metals shall not exceed specified mills per year penetration; ferrous, 0-2; brass, 0-1; copper, 0-1. Inhibitor shall be stable at equipment skin surface temperatures and bulk water temperatures of not less than 250° F and 125° F respectively. Heat exchanger fouling and capacity reduction shall not exceed that allowed by fouling factor 0.0005.

D. Pot Feeder: By-pass type, complete with necessary shut off valves, drain and air release valves, and system connections, for introducing chemicals into system, cast

iron or steel tank with funnel or large opening on top for easy chemical addition. Feeders shall be five gallon minimum capacity at 125 psig minimum working pressure.

E. Side stream Water Filter for Closed Loop Systems: Stainless steel housing, and polypropylene filter media with // polypropylene // stainless steel // core. Filter media shall be compatible with antifreeze and water treatment chemicals used in the system. Replaceable filter cartridges for sediment removal service with minimum 20 micrometer particulate at 98 percent efficiency for approximately five percent of system design flow rate. Filter cartridge shall have a maximum pressure drop of 2 psig at design flow rate when clean, and maximum pressure drop of 25 psig when dirty. A constant flow rate valve shall be provided in the piping to the filter. Inlet and outlet pressure gauges shall be provided to monitor filter condition.

E. Piping Specialties:

1. Blowdown valve: Include in a bleedoff piping assembly complete with inlet valve, strainer with flush valve, and blowdown valve with throttling provision.
    a) Solenoid type: UL listed, packless type with brass, bronze, or stainless steel wetted parts, NEMA Class A. Continuous duty, watertight, encapsulated coil, NEMA Class 1 enclosures, rated for pressure and temperature encountered and 120 VAC power supply.
    b) Solenoid pilot operated diaphragm type: UL listed, packless type with brass, bronze, or stainless steel wetted parts, NEMA Class A continuous duty, watertight, encapsulated coil, NEMA Class 1 enclosure, rated for 120 VAC power supply. Main valve shall be packless diaphragm type with cast iron body, bronze or stainless steel wetted metal trim and fasteners, nylon reinforced Buna N elastomer diaphragm, Buna N seats and seals, external throttling adjustment and non-slam closure.
2. Make-up water meter: Rotating disc, in sizes 1-1/2 inch and smaller and turbine type in sizes 2 inches and over with bronze or cast iron body rated for 125 psig, magnetic drive or mechanical impulse contactor matched to signal receiver, and six or more digit totalizer. Contactor shall be rated at 120 VAC, minimum one ampere resistive.
3. Chemical feed pump ancillaries: Manufacturer's standard devices, constructed of PVC, CPVC polypropylene, or AISI Type 316 stainless steel, to suit installation conditions; relief valves where not integral to chemical feed pump, anti-syphon valve, back-pressure valve(s), airlock vent valve, foot valve/strainer combination for suction piping.
4. Strainer: Rigid PVC or CPVC conforming to ASTM D1784 with cleanable AISI Type 304 or 316 stainless steel strainer element.
5. Valves for plastic piping: Ball type, with rigid PVC or CPVC body conforming to ASTM D1784, integral union ends and polytetrafluoroethylene seats and seals.
6. Testing materials and equipment: The water treatment laboratory shall provide chemical reagents, glassware, hardware, instruments, and expendables, to perform all necessary chemical test functions.

F. Chemicals: Provide sufficient chemicals for start-up and testing and twelve months operation from date of project acceptance.

1. Scale/corrosion inhibitor: Provide a concentrated liquid organic corrosion/scale/ fouling inhibiting formation without phosphates, chromates, zinc and other

materials in excess of allowable, local, effluent limits. Feed automatically. Maintain residual as determined by water treatment laboratory.

2. Maintain residual as determined by water treatment laboratory.

3. Microbiocides: Provide two different, one oxidizing and one non-oxidizing, concentrated algaecide-biocide formations containing no heavy metals and which are effective at maximum encountered pH. Alternate solutions as needed to effectuate selective kill without build-up of immunity. Period treatment with a chlorine releasing agent is permissible within allowable, local, effluent limits. Feed automatically. Develop peak concentration and maintain for minimum period as determined by water treatment laboratory.

G. Water Analysis: Confirm existing raw water analysis with COTR.

H. Conduct performance test to prove capacity and performance of treatment system.

1. Raw water total hardness,
2. PPM Concentration cycles
3. Raw water, Ph
4. System water, pH
5. Chemical solution used
6. Acid solution used
7. Quantity or chemical solution injected into system per cycle
8. Quantity of acid injected into system per cycle
9. Make up water required
10. Waste to drain requirement

2.5 CHEMICAL FEEDER (MANUAL POT TYPE)

A. Material:

1. Provide by-pass type manual chemical feeder in piping system at location indicated on drawings. Feeders shall be rated for not less than 300 psi and 225°F.

B. Feeder shall have 2 gallon capacity tank with strainer screen, threaded inlet and outlet for piping connections, removable sealed top cap for adding chemicals and safety feature which will not permit removal of top cap when pressure is on the feeder. Feeder shall be designed for use with briquette, powdered, and liquid chemicals for manual "slug type" feed.

C. Provide complete instructions for the use of the chemical feeder, recommended chemical treatment, the manufacturer and trade name of chemical, and source for obtaining the chemical. Information shall be framed and located on a wall near the chemical feeder. Frame shall have a Plexiglas cover.

D. Provide individual chemical feeders for the hot water and chilled water systems.

E. Accessories: Provide with shutoff valves on inlet and outlet, check valve and manual control valve on the inlet connection, unions in all piping connections, and drain valve. Install pipe from drain valve and end over floor drain. Installation shall be in accordance with the manufacturer's recommendations and as indicated on the drawings.

F. Manufacturers:

1. Dearborn Chemical Company: HV

2.6 EQUIPMENT AND MATERIALS IDENTIFICATION

Refer to Section, BASIC METHODS AND REQUIREMENTS (MECHANICAL).

PART 3. EXECUTION

3.1 INSTALLATION

A. Delivery and Storage: Deliver all chemicals in manufacturer's sealed shipping containers. Store in designated space and protect from deleterious exposure and hazardous spills.

B. Install equipment furnished by the chemical treatment supplier and charge systems according to the manufacturer's instructions and as directed by the Technical Representative.

C. Before adding cleaning chemical to the closed systems, all air handling coils and fan coil units should be isolated by closing the inlet and outlet valves and opening the bypass valves. This is done to prevent dirt and solids from lodging the coils. Provide additional valves and connections as necessary to properly isolate, flush and clean new pieces of piping and equipment in the existing systems and new systems.

D. After chemical cleaning is satisfactorily completed, open the inlet and outlet valves to each coil and close the by-pass valves. Also, clean all strainers.

END OF SECTION 232500

SECTION 23 31 13 – MECHANICAL DUCTWORK

GENERAL

WORK INCLUDES

Ductwork

Access doors

Backdraft dampers

Fire dampers

Fire smoke dampers

Volume dampers

Motor operated dampers

Airflow Monitoring Stations

Duct silencers

Rooftop hoods

Turning vanes

RELATED DOCUMENTS

National Fire Protection Association, NFPA:

NFPA 90A: Air Conditioning and Ventilating Systems.

NFPA 90B: Standard for Installation of Warm Air Heating and Air Conditioning Systems.

Underwriter's Laboratories, UL:

UL 181: Factory-Made Duct Materials and Air Duct Connections.

American Conference of Governmental Industrial Hygienists: Industrial Ventilation.

American Society of Heating, Refrigerating and Air Conditioning Engineers, ASHRAE:

Sheet Metal and Air Conditioning Contractors National Association, Inc., SMACNA:

SMACNA: HVAC Duct Construction Standards; First Edition 1985.

SUBMITTALS

Submit shop drawings for all materials in accordance with Division 1.

Product Data:

Submit manufacturer's catalog cuts, specifications, installation instructions, and dimensioned drawings for each type of manufactured ductwork accessories.

Include pressure drop curve or chart for each type, and size of motorized control damper.

Submit schedule showing manufacturer's figure number, size, location, rated capacities, and features for each fire damper, and control damper.

Submit fire protection rating, maximum velocity/pressure ratings and manufacturer's installation instructions for each fire damper. Velocity/pressure ratings shall include both ducted and non-ducted data.

Submit manufacturers certified test data on dynamic insertion loss, self-noise power levels and aerodynamic performance for reverse and forward flow test for each duct silencer.

Airflow Monitoring and Control

Submit product data sheets for airflow measuring devices indicating minimum placement requirements, sensor density, sensor distribution, and installed accuracy to the host control system.

Devices whose accuracy is the combined accuracy of the transmitter and sensor probes must demonstrate that the total accuracy meets the performance requirements of this specification throughout the measurement range.

Submit a schedule of airflow measuring devices indicating compliance with specified accuracy at minimum and maximum airflow rates.

Submit installation, operation and maintenance documentation.

Shop Drawings:

Submit ¼" scale fabrication drawings showing all necessary fittings, dampers and access doors. Coordinate fabrication drawings with field conditions prior to submittal. Changes in layout and design required to accommodate actual field conditions shall be specifically noted on drawings.

products

RECTANGULAR SHEET METAL DUCTWORK

Comply with ductwork type per the schedules on drawings.

Where ductwork is indicated to be exposed to view in occupied spaces, provide materials free from visual imperfections including pitting, seam marks, roller marks, oil canning, stains, discoloration, and other imperfections, including those which would impair painting. Sizes shown on drawings for rectangular ducts are sheet metal sizes, and where applicable an allowance has been made for duct liner insulation.

Ductwork shall be ASTM G90 galvanized steel: ASTM A525, lock-forming quality, 1.25 oz. zinc coating each side; (paint grip type where painted in exposed locations.). Gage, reinforcing and construction shall be in accordance with SMACNA Manual "HVAC Duct Construction Standards".

Longitudinal and corner seams shall be Types L1, L3 or L6 and in accordance with Figure 1-15 of SMACNA Manual "HVAC Duct Construction Standards".

Transverse joints and seams shall be made in accordance with Figure 1-4 of the SMACNA Manual "HVAC Duct Construction Standards" and of the following types:

Joints in the two sides of ducts shall be drive slip type T-1, T-2, or T-3.

Joints in the top and bottom of ducts shall be drive slip type as specified for sides, or shall be "S" slip types T-6, T-10, T-11, or T-14.

All take-offs from mains ducts shall be made using a 45° clinch collar to promote air flow in the direction of the take-off.

Housings and plenums shall be constructed of not less than 18 gage galvanized sheet steel with minimum l½" x l½" x 3/16" and 2" x 2" x 3/16" galvanized steel angles spaced at 4'-0" or less on centers for rigid and sturdy installation. Ducts less than 15" in depth may be reinforced with angles on top and bottom only.

The foregoing reinforcing for ducts and housings is the minimum and additional reinforcing shall be installed where necessary for elimination of excessive vibration and movement, and where in the opinion of the Engineer, additional reinforcement is necessary. Housing connections to walls, floors and ceilings shall be made airtight with angles and silicone based sealant. Angles shall be securely attached to the housing and the building construction.

Construct tees, bends, and elbows with radius minimum 1-1/2 times width of duct on center line. Where not possible and where rectangular elbows are used, provide single blade type turning vanes. Transitions in ductwork shall be tapered to an angle not to exceed 15° unless specifically shown or approved otherwise.

Spin-in sheet metal fittings shall be installed in supply air ducts for connections of round sheet metal and flexible round insulated ducts or plenum boxes. The spin-in fittings shall be furnished with adjustable balancing damper with wing nut locking operating lever.

Connections for spin-ins shall be made airtight by sealing around the entire perimeter of the joint between the rectangular duct and the spin-in fitting with semi-elastomeric thermoplastic duct sealant. Where rectangular duct dimension is less than the round sheet metal or flexible duct diameter, install a transition adapter for connection.

Stainless Steel Sheet: Where indicated, provide stainless steel complying with ASTM A 167; Type, 304; with No. 4 exterior finish where exposed to view in occupied spaces, No. 2B finish elsewhere. At a minimum stainless steel ductwork shall be provided on all low-wall returns from the frille to the first 90-degree elbow or fitting above the ceiling line. Protect finished surfaces with mill-applied adhesive protective paper, maintained through fabrication and installation.

Shop fabricate ductwork in 12 ft maximum lengths. Construct and reinforce ductwork as indicated in SMACNA's Standards as specified above.

Unless specifically detailed otherwise, use 45° laterals and 45° elbows for branch takeoff connections.

Fabricate duct fittings to match adjoining ducts, or equipment and to comply with duct requirements as applicable to fittings. Fabricate radius elbows with center-line radius equal to associated duct width; and include turning vanes in shorter radius elbows where necessary.

ROUND SHEET METAL DUCTWORK

Comply with ductwork type per the schedules on drawings.

All round ductwork shall be ASTM G90 galvanized inside and outside and shall be manufactured by a company who has had the manufacture of spiral duct as its principal business for at least 10 years. Round and flat oval sheet metal ducts shall be installed where indicated on the drawings.

Sheet metal gages and construction of round ducts shall be in accordance with the SMACNA Manual "HVAC Duct Construction Standards" for pressure class indicated on drawings. If pressure class is not indicated the ductwork shall be constructed to 2" w.g. pressure class.

Duct and fittings shall be installed with beaded slip joints fabricated on the fittings and couplings. Before assembly the outside of the joint slips shall be painted with duct adhesive/sealant and slipped into the mating duct. The connection shall be completed by utilizing sheet metal screws spaced at not more than 6 inches around the circumference of the duct. Use a minimum of 3 screws for all connections.

Where coupling is used between two pieces of duct fittings, the fastening as stated above shall apply for each piece joined by a coupling. After fastening with screws, all excess adhesive shall be wiped clean from the outside of the ductwork.

Longitudinal seams shall be spiral type and transverse joints shall be beaded sleeve type RT-1 or companion flange type RT-2 as shown in figure 3-2 of the SMACNA Manual "HVAC Duct Construction Standards". Round ducts shall be supported with not less than 1" wide, 16-gauge galvanized steel straps as shown in figure 4-4 of the SMACNA Manual "HVAC Duct Construction Standards".

The use of wire for the support of round ducts will not be acceptable. The complete installation of duct systems shall provide a neat appearance, with duct runs hung level and without noticeable sag or misalignment.

Manufacturers:

United Sheet Metal
Semco
Wesco
Eastern Sheet Metal

ROUND FLEXIBLE INSULATED DUCTS

Flexible ducts shall be round, insulated duct, factory fabricated of a spring steel wire helix or flat steel spiral covered by and bonded to a polymeric or vinyl-coated fiberglass fabric for leak-tight air seal. Inner liner shall be covered with 1" thick glass fiber insulation and an outside flexible, puncture-resistant and scuff resistant vapor barrier jacket.

Duct shall be U.L. listed, Class I, and shall conform to the requirements of NFPA 90A. Ducts shall be rated for not less than 4" W.G. static pressure and for air velocities up to 2500 fpm.

Flexible duct sizes and installation shall be as shown on the drawings. Flexible duct connections to rectangular ducts or plenum housings shall be made with spin-in fittings equipped as hereinbefore specified.

The inner lining shall be secured in place to the spin-in fitting or round duct with nylon or steel draw-bands for an airtight connection. The insulation and outer vapor barrier jacket shall be drawn up to completely cover the connection and shall be secured in place with a second nylon or steel draw-band for a vaportight connection.

The maximum installed length of the flexible duct shall not exceed 5 feet. Flexible ducts shall be supported with not less than 1" wide, 16 gauge steel straps, the use of wire for the support of flexible ducts will not be allowed.

Manufacturers:

Thermaflex: G-KM
Wiremold
Atco

ACCESS DOORS IN DUCTS AND HOUSINGS

All ducts and housing shall have hinged access doors for access to all automatic dampers, temperature sensing elements, control devices, fire dampers, damper actuators, air filters and all other items within the ductwork or housing which requires inspection, service or adjustment.

All access doors shall be sandwich type construction with insulation between the outer and inner sheet metal panels. Frame shall be minimum 22 gauge galvanized steel with seal. Door shall be hinged and minimum 22 gauge galvanized steel with 1" thick fiber glass insulation. Access doors shall be rated for minimum 2" w.g. static pressure.

Doors shall be gasketed with neoprene or sponge rubber gaskets. Foam plastic gaskets will not be accepted. The Contractor shall be responsible for the location of all access doors regardless of notations on drawings.

Access doors in ductwork shall be the size indicated on the drawings. Where the size is not shown the minimum size shall be 12" x 18". Where the ductwork dimensions will not accept this size, the access door shall be as large as the ductwork dimensions will accept.

All access doors in ductwork for access to fire dampers, motor operated control dampers, or counterbalanced backdraft dampers shall have view ports of wire-glass or Plexiglas. The access doors shall be gasketed airtight with an area of not less than 25 sq. inches for observation of dampers.

Hardware: Continuous aluminum piano type hinge; 1 cam latch, except 2 cam latches on sizes over 14 " x 14".

All access doors within the laboratory exhaust system shall be constructed of type 304 stainless steel with 304 stainless steel hardware and fasteners.

Manufacturers:

Ruskin Mfg. Co.: ADHW-24

Air Balance, Inc.

Prefco

RECTANGULAR VOLUME DAMPERS

Where shown on plans, and where required to properly balance the airflow in the HVAC supply, return, and exhaust ductwork systems provide rectangular, manual balancing type, volume control dampers.

Frames shall be minimum 16 gage galvanized steel channel construction with corner braces. Frame sizes shall be available from 6" x 5" to 48" x 48". Fabricate single blade volume dampers for duct sizes to 9-1/2" x 30". Axles shall be 1/2" hex with molded synthetic bearings. Control shaft shall be 3/8" square plated steel construction.

Damper blades shall be maximum 8" wide with opposed blade operation, and 16 gauge galvanized steel construction. Damper blades shall be center and edge crimped and positively locked to hex axles. Provide factory mounted locking hand quadrants.

All volume dampers within the laboratory exhaust system shall be constructed of type 304 stainless steel with nylon shafts. Attachments shall be made with stainless steel screws and sealed airtight with acid-resistant elastomeric silicone based sealant.

Manufacturers:

Ruskin Mfg. Co.: MD35 Series
Air Balance, Inc.
Dowco Corp.
Nailor Industries

ROUND VOLUME DAMPERS

Where shown on plans, and where required to properly balance the airflow in the HVAC supply, return, and exhaust ductwork systems provide round, manual balancing-type, volume control dampers.

Frame and blade shall be minimum 20 gauge galvanized steel construction. Frame sizes shall be available from 4" to 20" diameter. Control shaft shall be 3/8" square axle shaft extending beyond frame through factory mounted, locking hand quadrant.

Bearing construction shall be molded synthetic. Finish shall be mill galvanized. Damper assembly shall be suitable for 1500 fpm velocity, and 250°F operating temperature.

All volume dampers within the laboratory exhaust system shall be constructed of type 304 stainless steel with nylon shafts. Attachments shall be made with stainless steel screws and sealed airtight with acid-resistant elastomeric silicone based sealant.

Manufacturers:

Ruskin Mfg. Co.: MDRS25 Series
Air Balance, Inc.
Dowco Corp.
Nailor Industries

VOLUME DAMPERS

Where shown on plans, and where required to properly balance the airflow in the HVAC supply, return, and exhaust ductwork systems provide rectangular, manual balancing type, volume control dampers. Provide with cable control above inaccessible ceiling systems and manual quadrant where accessible.

Furnish and install, at locations shown on plans, in accordance with schedules and as needed to balance airflow in HVAC systems. Provide commercial grade control dampers and remote cable control system that meet the following minimum standards. Dampers mounted in inlet of diffuser are not acceptable. Ceiling access panels are not acceptable.

Dampers shall be round butterfly design or rectangular opposed blade design for low pressure drop. Round damper shall be heavy duty spiral shell with a 20 gauge “V” style blade, CRS steel shaft and oil impregnated bronze bearings requiring no lubrication.

Rectangular dampers shall be opposed blade style for even distribution of air over face of grille. Damper shall be constructed of .050 extruded aluminum double channel frame and stainless steel hardware including the damper slide. Blades shall be .050 extruded aluminum with longitudinal reinforcing beads. Blades shall be installed in individual Teflon blade bushings in the damper frame. Manufacturer shall supply all necessary hardware for simple installation of remote cable controls system including the Bowden aluminum angle bracket and the Bowden control hub to accommodate the cable control system mounted on the damper.

Cable control system shall consist of Bowden cable .054” stainless steel control wire encapsulated in 1/16” flexible galvanized spiral wire sheath to insure positive operation for up to 50’ (less if there are multiple turns or bends). Control kit shall be designed for use with internally or externally controlled round or rectangular dampers and shall consist of 14 gauge steel rack and pinion gear drive to convert rotary motion to push-pull motion. Control shaft shall be D-style flattened_” diameter with 265° rotation providing graduations for positive locking control. Control mounting through ceiling via 1” or 3” inconspicuous access port.

Manufacturers:

Young Regulator

branch take-off fittings

Where shown on plans provide from rectangular ductwork to round branch ductwork high efficiency take-off type fitting. This fitting shall be minimum 24 gauge, have minimum 1/4" diam. Shaft thru damper, and have locking quadrant. Square to round transition shall be minimum 26 guage.

Fitting shall be equal to Buckley model BMD-HD with damper if shown on the plans. Fitting shall be minimum 22 gauge with full rod thru damper (not clamping), adjustable quadrant setpoint (no wing nut setting), and bell type take-off.

Equal fitting can be conical type or HETO type (rectangular to round) take-off. Spin-ins are not allowed.

MOTOR-OPERATED DAMPERS (RECTANGULAR)

Where shown on plans provide rectangular, motor operated, low leakage, opposed blade type, control dampers of the sizes indicated.

Low leakage dampers shall have published leakage data certified under ACMA certified ratings program showing leakage through a 48"x 48" damper at 4" w.g. pressure difference to be not less than 6.2 cfm/sq. ft.

Damper frames shall be constructed from 5" x 1" x .125" 6063T5 extruded aluminum hat channel with hat mounting flanges on both sides of frame. Each corner shall be reinforced with two die formed internal braces and machine staked for maximum rigidity.

Damper blades shall be airfoil type extruded aluminum (maximum 6" depth) with integral structural reinforcing tube running full length of each blade. Blade edge seals shall be extruded vinyl double edge design with inflatable pocket which shall enable air pressure from either direction to assist in blade to blade seal off. Blades seals shall be locked in extruded blade slots without the use of cement, yet shall be easily replaceable in the field.

Bearings shall be non-corrosive two piece molded synthetic. Axles shall be square or hexagonal (round not acceptable) to provide positive locking connections to blades and linkage.

Manufacturers:

Ruskin Mfg. Co.: Series CD-60
Arrow United Industries
Penn Ventilator Co., Inc.
Nailor Industries

TURNING VANES

Constructed of same material as ducts where they are installed, but minimum 22-gauge, non-adjustable 90 degree turns. Turning vanes shall be single thickness, formed blade shape. Turning vanes shall be positioned and held in place with pre-formed guide rails. They shall be airfoil type.

Manufacturers:

Aerodyne airfoil

Barber-Colman

Carnes Co.

Tuttle and Bailey

EXECUTION

INSPECTION

Visit job site prior to fabrication and installation to verify all requirements, connections and conditions. Provide instructions to all parties with regard to shop drawing information and requirements.

Starting work indicates acceptance of other in-place work.

Before installation inspect building dimensions and service rough-in, including means of access for conditions affecting shop fabrication, equipment delivery and the installation of all ductwork and accessories.

Provide inserts and anchors into other work for the support of this work.

Ensure these items are installed in the proper locations.

Include fastening devices to attach work.

Use the proper fasteners and anchors for the materials encountered and the operation and service of the equipment.

Install ductwork and all accessories in accordance with the manufacturer's instructions using workers skilled and familiar with the items and the installation specifications.

Shop assemble and test work prior to delivery to job site wherever possible. Sequence the installation and erection of work to ensure mechanical and electrical connections are affected in an orderly and expeditious manner.

Coordinate all cutting, fitting and patching with the other trades involved to ensure a complete and finished installation.

METHOD OF INSTALLATION

Comply with all of the manufacturer's best installation recommendations and instructions for all ductwork and accessories.

Furnish and install roof curbs for all roof mounted ductwork and accessories. Curbs shall be as specified in Section 230529 of these specifications and the height shall be as indicated on drawings, but shall be not less than 13½" from base to top of nailer strip.

Securely anchor roof curb to roof structure. Securely anchor ductwork and accessories to roof curb. Coordinate flashing and counterflashing with roofing installer for a watertight installation.

Items with hinged bases shall be furnished with padlock hasps for padlocking. The anchoring of the hasp components shall be such that they cannot be removed when in the locked position.

Furnish and install all steel members and accessories necessary to provide a complete and finished installation.

Ducts shall be constructed, sealed and made airtight for pressures indicated on drawings. If pressure class is not indicated on the drawings, the ducts shall be sealed to 2" w.g. pressure class. All ducts shall be sealed in accordance with SMACNA Seal Class A. Fabricate and seal ductwork to maintain a maximum air leakage, inward or outward as follows:

Each 50 feet main or branch duct: 1%.

Total leakage any complete system: 5% of total air handled.

Provide openings in ductwork to accommodate thermometers and controllers. Provide Pitot tube openings for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings provided in insulated or lined ductwork, install insulation material inside metal ring.

Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities to the greatest extent possible.

Furnish and install all manually operated volume dampers, and devices where indicated on drawings and as required to insure proper balancing and control of air systems. Volume controllers shall be equipped with proper type operators for adjustment with final balance position clearly marked.

The interior of all ducts and boots that can be seen through grilles, registers and diffusers shall be coated with flat black paint, except where duct is lined with black coated insulation.

Where exposed ductwork passes through non fire-rated walls the space between the duct and the opening shall be closed with a compacted fill of 3/4 lb. density fiberglass. Provide and install sheet metal collar of not less than 20-gauge paint-grip type galvanized sheet steel on all side of the ductwork. Overlap the opening and ductwork by 1½" on all sides. Seal collars around ductwork and opening with silicone elastomeric sealant.

The space between fire damper sleeve and the building construction shall be tightly sealed off with galvanized steel angle frame (not less than 10 gauge) on each side of opening. Securely attached angles to fire damper sleeve and to building construction to comply with UL and NFPA requirements for fire damper installation.

Where dampers are installed in ductwork, and are not located behind a removable air grille or register, the Contractor shall provide an airtight access door in rectangular ducts and an airtight access panel in round ducts. These are required for access to the damper, fusible link and for inspection. Provide and install the access doors and panels regardless of whether they are indicated on drawings or not.

Each fire damper shipment shall include the manufacturer's UL installation instructions. All fire dampers shall be installed in strict accordance with the manufacturer's UL installation instructions.

Control Components: Install all control components in sheet metal equipment or ductwork as shown and/or indicated, including all automatic and manual control dampers, all flow measuring stations, all fire dampers, and all smoke dampers. Also any temperature sensors or indicators, humidity sensors or indicators, flow sensors, switches, or indicators, freeze stats, static pressure sensors, and end position switches that are not DDC controls.

Routing: Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Locate insulated ductwork for 1" clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate layout with suspended ceiling and lighting layouts and similar finished work. Coordinate with insulator to prevent installation of duct in such a way, that insulator cannot apply insulation.

Penetrations: Where ducts pass through interior partitions and exterior walls, seal space between construction opening and duct or duct insulation with sealant and sheet metal flanges of two gauges heavier than duct. Overlap opening on 4 sides by at least 1-1/2". Fasten to duct and substrate. Where ducts pass through fire rated floors, walls, or partitions, provide fire dampers, or fire/smoke dampers if indicated and provide firestopping between duct and substrate, as specified in Section 230500, “Mechanical General Provisions.”

Rectangular tees, bends and elbows shall be provided with turning vanes. In addition, provide manually operated volume dampers, as indicated and as needed, to ensure proper balancing and control of air systems.

STAINLESS STEEL DUCTWORK

Stainless steel ductwork shall be provided for exposed ductwork in clean rooms for all ductwork installed inside chases or walls, and elsewhere as indicated on Drawings.

Strip protective paper from stainless ductwork surfaces, and repair finish wherever it has been damaged.

FLEXIBLE DUCTS

Flexible duct shall only be used where shown on the drawings. The inner liner shall be secured in place to the round duct with nylon or steel draw-bands and sealed for an airtight connection, and then the insulation and outer vapor barrier jacket shall be drawn up to completely cover the connection and shall be secured in place with a second nylon or steel draw-band for a vapor tight connection.

Flexible ducts shall be supported with 2" wide, 20 gauge steel straps, the use of wire for the support of flexible ducts is not acceptable. Where flexible duct is used as a bend or elbow, the included angle or the bend shall not exceed 90 degrees in any plane.

Maximum Length: For any duct run using flexible ductwork, do not exceed 5'-0" extended length.

START-UP AND TESTING

Leakage Tests: After each duct system or portion of a duct system is completed, this contractor shall test the section in accordance with the SMACNA HVAC Air Duct Leakage Test Manual. The tests shall verify that the entire duct system for each air handling unit has a total leakage rate of 1% or less of the total system design cfm. Leakage from non-duct components (fire dampers, smoke dampers, volume control boxes, etc.) are an integral part of overall system leakage, and these components shall be included in duct leakage tests. Contractor shall be responsible for any remedial efforts directed at products in order to bring the system or section into compliance with the leakage rate specified.

Provide all blank off covers, fan connection points, and test holes required. Seal up of all test holes and removal of all covers after section of duct or entire duct system has been tested and approved as acceptable.

By means of a suitable fan and test manometers, the systems shall be pumped up to approximately 3.5" w.g. of static pressure and held for a period of ten (10) minutes. After this period the pressure shall be reduced to 2" w.g. of static pressure and the duct systems shall be visually and audibly inspected to determine that all joints are tight. After all leaks are properly sealed, the duct shall be repressurized to 3.5" w.g. of static pressure and held for ten (10) minutes and then reduced again to 2" and all leaks rechecked. Contractor shall repair leaks and repeat tests until total leakage is less than 1% of total system design air flow.

Contractor is responsible for the costs associated with any retests required due to total system duct leakage greater than the 1% of total cfm value.

Contractor is responsible for submitting copies of certified calibration data for leakage test apparatus and the reports on the leakage tests. The report shall give an accurate description of the test procedure and results including any remedial action that was needed to obtain an acceptable test. Owner or Owner's Representative may be present for tests at Owner's discretion.

ADJUSTING AND CLEANING

Remove protective ductwork caps or cover as it is being installed.

Clean ductwork internally, unit by unit as it is installed, of dust and debris. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.

Temporary Closure: At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris until time connections are to be completed.

Balancing: This contractor shall provide the initial balancing and adjusting of all air handling systems. All final testing and balancing will be by a testing and balancing contractor. This contractor shall assist during the final balancing and testing. Refer to Specification Section - "Testing, Adjusting, and Balancing" for air distribution balancing of metal ductwork. Seal any leaks in ductwork that become apparent in the balancing process.

Clean, inspect and adjust dampers prior to system start-up to ensure equipment is operational and complete in all respects, including all accessories. Verify that all dampers are in the proper position before starting equipment.

END OF SECTION 233113

SECTION 23 34 16 – CENTRIFUGAL EXHAUST FANS

PART 1 - GENERAL

DESCRIPTION OF WORK

Work Includes:

Centrifugal roof mounted exhaust fans
Centrifugal upblast roof mounted exhaust fans
In-line centrifugal exhaust fans
Mixed Flow In-Line Exhaust Fans for Kitchen Applications

RELATED DOCUMENTS

Flame-Smoke Ratings:

Flame spread: 25 or less
Smoke developed: 50 or less

Air Movement and Control Association, AMCA:

Comply with AMCA standards for testing and rating fans.

American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., ASHRAE

Sheet Metal and Air Conditioning Contractors National Association, Inc., SMACNA:

Comply with SMACNA duct construction standards for air handling units.

QUALITY ASSURANCE

The manufacturer shall provide the Owner with a one-year warranty. The manufacturer shall replace any equipment, assembly or part that fails due to defective material or workmanship during the warranty period.

Upon written notice from the Owner or Engineer the Contractor shall promptly repair any defects occurring within a one-year period from the date of final acceptance. All warranty work shall be performed by the Contractor without any cost to the Owner.

SUBMITTALS

Submit shop drawings for all materials in accordance with Division 1, Section 01300.

Shop Drawings:

Submit assembly type shop drawings indicating unit dimensions, construction details, field connections and structural framing.

Product Data:

Submit manufacturer's installation, operation and maintenance instructions. Include fan performance curves showing CFM, static pressure, fan wheel RPM and BHP operating point clearly identified on the curve.

Submit recommend spare parts list and cost.

PART 2 - PRODUCTS

DISCONNECT SWITCHES

Disconnect switches where not furnished by the Electrical Contractor shall be furnished by the Mechanical Contractor. Disconnect switches shall be furnished and installed in accordance with the requirements of Division 26.

Each disconnect switch shall be NEMA 3R rated and shall include one 3 pole, 600 volt, quick-make, quick-break, manually operated switch. The handle on the switch shall have provisions to lock it in the 'open' or 'closed' position. Refer to schedule on drawings for electrical voltage characteristics.

MOTORS AND DRIVES

Motor speeds shall be as scheduled, and the horsepower shall be not less than shown. Motors shall be selected for quiet operation and for non-overloading performance characteristics. Motors shall be heavy-duty permanently lubricated sealed ball bearing type.

Motor voltage characteristics shall be as shown on the drawings. Motors shall be of the proper design for the starting and running torque requirements. Sheaves shall be adjusted for proper air delivery. Furnish controls as scheduled on drawings and as specified in Division 23.

All fans shall be V-belt driven unless noted otherwise. Drives shall be designed for not less than 150% of motor horsepower capabilities with cast-iron fan sheave and adjustable cast-iron motor sheave.

Drive belts shall be oil-resistant, non-static, non-sparking type with 24,000-hour life expectancy. Ball bearings shall be flanged, permanently lubricated, permanently sealed, and capable of 200,000 hours bearing life unless noted otherwise.

CENTRIFUGAL ROOF MOUNTED EXHAUST FANS

Furnish and install roof mounted exhaust fans where shown on drawings. Fan sizes, arrangements, capacities and conditions shall be as scheduled, and as shown on the drawings.

Fans shall be downblast discharge type and shall be constructed and rated according to AMCA, with bird screen guard on discharge outlet. Housing, inlet cone and fan wheel shall be aluminum construction. Fan wheels shall be statically and dynamically balanced. Steel fan shaft shall be turned, ground and polished to close tolerances in relationship to hub and bearings.

Motor and drives shall be enclosed in a weather-tight compartment separated from the exhaust air stream. Air for cooling the motor shall be supplied to the compartment, by way of an air passage, from an area not contaminated by exhaust fumes.

The complete drive assembly shall be mounted on vibration isolators. The drive assembly and fan wheel shall be removable from the support structure.

Manufacturers:

Loren Cook: 'ACE-B' Series
Penn Ventilator
Greenheck Fan
Pennberry.
Twin City Fan.

IN-LINE CENTRIFUGAL EXHAUST FAN

Furnish and install in-line centrifugal exhaust fans where shown on drawings. Fan sizes, arrangements, capacities and conditions shall be as scheduled, and as shown on the drawings.

Fans shall have inlet and discharge diameter not less than shown on schedule and shall be constructed and rated according to AMCA. Fans shall be furnished with heavy duty, self-aligning, grease lubricated, ball bearings with heavy duty pillar block mountings. Fan bearings shall have extended grease fittings. Drives shall be equipped with belt guard.

Manufacturers:

Loren Cook: "Centri-Vane"
Penn Ventilator
Greenheck Fan
Pennberry
Twin City Fan

MIXED FLOW IN-LINE EXHAUST FAN FOR KITCHEN APPLICATIONS

Refer to specification section 233813 “Kitchen Exhaust Systems”.

PART 3 - EXECUTION

INSPECTION

Visit job site prior to equipment installation to verify acceptance of other in-place work.

Before installation inspect building dimensions and service rough-in, including means of access for conditions affecting delivery and installation of all equipment and accessories.

Provide inserts and anchors into other work for the support of this work.

Ensure these items are installed in the proper locations.
Include fastening devices to attach work.
Use the proper fasteners and anchors for the materials encountered and the operation and service of the equipment.

Install exhaust fans and all accessories in accordance with the manufacturer's instructions using workers skilled and familiar with the items and the installation specifications.

Shop assembly and test work prior to delivery to job site wherever possible. Sequence the installation and erection of work to ensure mechanical and electrical connections are affected in an orderly and expeditious manner.

Coordinate all cutting, fitting and patching with the other trades involved to ensure a complete and finished installation.

METHOD OF INSTALLATION

Comply with all of the fan manufacturer's best installation recommendations and instructions for all exhaust fans and accessories.

Furnish and install roof curb for each roof mounted exhaust fan. Curbs shall be as specified in Section 230529 of these specifications and the height shall be as indicated on drawings, but shall be not less than 13½" from base to top of nailer strip.

All roof mounted fans shall be installed with gravity operated backdraft dampers installed in the roof curb. Dampers shall be as specified in Section 233113 “Mechanical Ductwork” of these specifications.

Securely anchor roof curb to roof structure. Securely anchor exhaust fan base to roof curb. Coordinate flashing and counterflashing with roofing installer for a watertight installation.

Exhaust fans with hinged bases shall be furnished with padlock hasps for padlocking. The anchoring of the hasp components shall be such that they cannot be removed when in the locked position.

Inlet and discharge connections for in-line centrifugal exhaust fans shall be made with flexible ductwork connections.

In-line centrifugal exhaust fans shall be installed with spring hanger type or rubber-in-shear hanger type vibration isolators. Furnish and install all steel members and accessories necessary to provide a complete and finished installation. Vibration isolators shall be selected as recommended by [ASHRAE 1991 Applications Handbook - Chapter 42 Sound and Vibration Control].

Provide flexible duct connection to fan base for laboratory process exhaust fan installations.

Install each wall mounted propeller exhaust fans with a 2-position motor operated discharge damper. Damper shall be full open when fan is energized and shall be full closed with fan is de-energized. Provide not less than the manufacturer's recommended minimum distance between the exhaust fan and the damper.

Provide not less than 2" x2" x 1/8" welded steel angle support brackets for all wall mounted propeller exhaust fans. Support brackets shall be securely attached to the wall structure and the exhaust fan assembly with removable fasteners.

START-UP AND TESTING

Refer to Section 23 0923 of these Specifications for Testing, Balancing and Start-up requirements.

Clean, inspect and adjust exhaust fans prior to start-up to ensure equipment is operational and complete in all respects, including all accessories.

END OF SECTION 233416

SECTION 23 37 13 – MECHANICAL DIFFUSERS, REGISTERS AND GRILLES

GENERAL

DESCRIPTION OF WORK

Diffusers

Grilles and Registers

Outside Louvers

Roof Hoods

RELATED DOCUMENTS

Air Diffusion Council, ADC

American Society of Heating, Refrigerating and Air Conditioning Engineers, ASHRAE:

1. *Make air flow test and sound level measurements in accordance with ADC Equipment Test Codes and ASHRAE Standards.*

National Fire Protection Association, NFPA:

NFPA 90A: Air Conditioning and Ventilating Systems
NFPA 90B: Standard for Installation of Warm Air Heating and Air Conditioning Systems

QUALITY ASSURANCE

The manufacturer shall provide the Owner with a one-year warranty. The manufacturer shall replace any equipment, assembly or part that fails due to defective material or workmanship during the warranty period.

Upon written notice from the Owner or Engineer the Contractor shall promptly repair any defects occurring within a one-year period from the date of final acceptance. All warranty work shall be performed by the Contractor without any cost to the Owner.

SUBMITTALS

Submit shop drawings for all materials in accordance with Division 1, Section 013300.

Shop Drawings:

Submit shop drawings covering each item together with schedule of outlets and inlets.

Product Data:

Submit manufacturer's data for air distribution equipment, including specifications, capacity and noise criteria. Furnish catalog cut sheets, product specifications and dimensioned drawings for each type of diffuser, grille, register, louver and hood.

Include performance tables marked to clearly indicate CFM, pressure drop, neck velocity, throw and noise criteria value for each item submitted.

Throw values shall be given in feet to terminal velocities of 150 FPM, 100 FPM and 50 FPM. All pressures shall be given in inches of water.

Catalog cut sheets shall be clearly marked in red ink to indicate the performance data for each item submitted.

Submit certified copies of tests showing water penetration for louvers in accordance with AMCA Standard 500 and complying with the requirements of the AMCA Certified Ratings Program.

Submit anodize finish color charts for louvers with shop drawings.

PRODUCTS

GENERAL REQUIREMENTS

Rate units in accordance with ADC standards. Base air outlet application on space noise level of NC [35] maximum. Provide baffles to direct air away from walls, columns, or other obstructions within the radius of diffuser operation.

Provide boots of same manufacturer as grille or register fitted with equalizer deflector or diffuser plate as noted or scheduled on drawings. All units shall be furnished with sponge rubber gasket seal around edge with mounting surface secured in place. Foam plastic gaskets are not acceptable. All units shall have finish as specified.

Where supply registers are installed on exposed ductwork provide an inverted collar on the duct. The outside dimensions of the inverted collar shall be the same as the outside dimensions of the register so that the edges are even with one another. The depth of the collar shall be sufficient to contain the register and volume control damper within the collar. The register and damper shall not extend back into the duct. The collar shall not be in excess of the depth of the register and damper.

Refer to Architectural reflected ceiling drawings for the type of ceiling construction to determine the exact mounting frame required for each ceiling mounted grille, register and diffuser.

Provide quantity and sizes of grilles, registers and diffusers as indicated on drawings. Coordinate with other work, including ceiling layout, ductwork and ductwork accessories, to interface installation of units properly with other work and existing conditions.

Provide reinforcing bars on the back side of blades for grilles and registers when blades are 12" long or greater. Install grilles and registers for minimum sight through unit when viewed from floor.

REGISTERS

Supply Registers SR-1 shall be steel, rectangular, double deflection type, with individually adjustable horizontal and vertical blades. Furnish units with heavy formed 1-1/4" steel borders and countersunk screw holes suitable for surface mounting.

Blades shall be spaced 3/4" on centers with friction pivots which allow individual blade adjustments without loosening or rattling. Front blade shall be parallel to the long dimension. Registers shall be furnished with gang-operated, opposed blade type, volume control dampers. Dampers shall be adjustable from the face of the register with screwdriver.

Secure overlapping frame of register to inverted duct collar, or to wall construction with oval head, countersunk screws. Screw heads shall be enameled to match the border. Finish for registers shall be off-white baked enamel.

Manufacturers:

Titus: 272RL
E.H. Price: 520L
Carnes Co.: RTDA
Nailor Industries

Supply Registers SR-2 shall be steel, rectangular, single deflection type, with individually adjustable vertical blades. Furnish units with heavy formed 1-1/4" steel borders and countersunk screw holes suitable for surface mounting.

Blades shall be spaced 2" on centers with friction pivots which allow individual blade adjustments without loosening or rattling. Front blade shall be parallel to the short dimension. Registers shall be furnished with gang-operated, opposed blade type, volume control dampers. Dampers shall be adjustable from the face of the register with screwdriver.

Secure overlapping frame of register to inverted duct collar, or to wall construction with oval head, countersunk screws. Screw heads shall be enameled to match the border. Finish for registers shall be off-white baked enamel.

Manufacturers:

Titus: 121RS
E.H. Price
Carnes Co.
Nailor Industries

Return Registers RR-1 shall be steel construction and rectangular configuration. Provide one set of fixed blades parallel to the long dimension. Registers for lay-in ceiling installation shall be furnished with Titus type 3 borders. Registers for installation in walls or hard ceilings shall be furnished with Titus type 1 border for surface mounting.

Blades shall be spaced 1/2" on centers with 30° deflection. Registers shall be furnished with gang-operated, opposed blade type, volume control dampers. Dampers shall be adjustable from the face of the register with screwdriver.

Secure overlapping frame of register to inverted duct collar, wall or ceiling construction with oval head, countersunk screws. Screw heads shall be enameled to match the border. Finish for registers shall be off-white baked enamel.

Manufacturers:

Titus: 25RL
E.H. Price
Carnes Co.
Nailor Industries

Exhaust Registers ER-1 shall be steel construction and rectangular configuration. Provide one set of fixed blades parallel to the long dimension. Registers for lay-in ceiling installation shall be furnished with Titus type 3 borders. Registers for installation in walls or hard ceilings shall be furnished with Titus type 1 border for surface mounting.

Blades shall be spaced 1/2" on centers with 30° deflection. Registers shall be furnished with gang-operated, opposed blade type, volume control dampers. Dampers shall be adjustable from the face of the register with screwdriver.

Secure overlapping frame of register to inverted duct collar, wall or ceiling construction with oval head, countersunk screws. Screw heads shall be enameled to match the border. Finish for registers shall be off-white baked enamel.

Manufacturers:

Titus: 25RL
E.H. Price
Carnes Co.
Nailor Industries

CEILING SUPPLY DIFFUSERS

Supply Diffuser SD-1 shall be 12" x 12" or 24" x 24" square louvered face type as shown on the drawings, with round neck ductwork connection. Diffusers for lay-in ceiling installation shall be furnished with Titus type 3 borders. Diffusers for installation in hard ceilings shall be furnished with Titus type 1 border for surface mounting.

Diffusers shall deliver airflow in a 360° pattern unless blank-off plates (sectorizing baffles) are indicated on the drawings. Blank-off plates shall be installed in the neck of the diffuser when shown to alter the discharge pattern for walls, columns or other obstructions.

Provide a Titus model D-75 opposed blade damper for final trim balancing. Damper shall be adjustable from the face of the diffuser with screwdriver, and shall be suitable for installation with flexible ductwork. Diffuser cones shall be die-stamped one piece construction of heavy gauge steel. Finish for diffusers shall be off-white baked enamel.

Manufacturers:

Titus: TMS
E.H. Price: SCD
Carnes Co.: SF
Nailor Industries

Supply Diffuser SD-2 shall be square or rectangular louvered face type as shown on the drawings. Ductwork connection to diffuser neck shall be square or rectangular. Diffusers for lay-in ceiling installation shall be furnished with Titus type 3 borders. Diffusers for installation in hard ceilings shall be furnished with Titus type 1 border for surface mounting.

Diffusers shall deliver airflow in a 1-way, 2-way, 3-way or 4-way pattern as indicated on the drawings. Provide throw reducing vanes only where specifically called for on the drawings.

Provide a Titus model AG-35 opposed blade damper for final trim balancing. Damper shall be adjustable from the face of the diffuser with screwdriver, and shall be the same material as the diffuser. Diffusers shall be heavy gauge steel construction with removable cores. Finish for diffusers shall be off-white baked enamel.

Manufacturers:

Titus: TDC
E.H. Price: SMD
Carnes Co.
Nailor Industries

Supply Diffuser SD-3 shall be high capacity laminar flow type incorporating radial blades to create a horizontal swirling air pattern. Diffuser shall have at a minimum 8 inch deep galvanized steel intake plenum with 10" diameter round neck ductwork connection.

The diffuser face shall be painted white. Diffusers for lay-in ceiling installation shall be furnished with type 'Q' frame for lay-in T-bar. Diffusers for installation in hard ceilings shall be furnished with type 'Q' frame for surface mounting.

Manufacturers:

Trox: FD
E.H. Price
Nailor Industries

Supply Diffuser SD-4 shall be a high capacity, low velocity, downward, laminar airflow type. Diffusers shall have perforated face plate with 3/32" diameter holes on 1/4" centers in a staggered 60° pattern. Provide disk type volume control damper located in the neck of the diffuser.

Volume control dampers shall be adjustable with a screwdriver through a removable plug located in the face of the diffuser. The diffuser face shall be removable by utilizing 1/4 turn fasteners and shall be furnished with safety chains to prevent accidental dropping of perforated face plate.

Furnish internal baffles to distribute airflow evenly across the perforated face plate. Diffusers for lay-in ceiling installation shall be furnished with Titus type 3 borders. Diffusers for installation in hard ceilings shall be furnished with Titus type 1 border for surface mounting.

Diffusers shall be stainless steel with #01 finish. Provide 7" and 10" diameter round neck ductwork connections for diffusers as indicated on the drawings.

Manufacturers:

Titus: TLF
E.H. Price: LFD
Nailor Industries

Linear Supply Diffusers LSD-1 shall be furnished with 1/2", 3/4" or 1" wide slots as indicated in the drawings. Linear diffusers shall be 1-slot, 2-slot, 3-slot or 4-slot arrangement, and 24", 30", 36", 48" or 60" in length as shown on the drawings. Slot edges shall be double thickness 'hemmed' configuration.

Linear diffuser shall be suitable for rigid or flexible supply duct connection and for installation in a lay-in T-bar ceiling grid system, or a hard ceiling system. Provide Modulinear 'Ice-Tong' type pattern controllers mounted in each slot. The pattern controllers shall provide 180° adjustment of the discharge direction, and volume control from the face of the diffuser.

Furnish linear diffusers with factory installed T-bars and T-bar mounting clips. Furnish each diffuser with a factory fabricated, and internally insulated supply plenum for round or oval duct connections of quantity and size as shown on the drawings. Diffusers and supply plenum shall be steel construction with extruded aluminum pattern controllers.

The total combined height of the diffuser and supply plenum shall not exceed 12". The plenum shall be furnished with a coated mill finish. The pattern controllers shall be provided with a black baked enamel finish. The T-bars shall be furnished with a white baked enamel finish.

Provide center notch for T-bar where 48" long linear diffusers are installed in two 24" ceiling modules. Furnish diffusers suitable for straddle mounting of T-bars where indicated on drawings. Provide plaster mounting frame for each diffuser installed in hard ceiling construction. The mounting frame shall be 1-1/2" high and 1" wide. The diffuser shall be installed on the inside lip of the mounting frame.

Manufacturers:

Titus: TBD-30
E.H. Price: TBD-3
Nailor Industries

Linear Supply Diffusers LSD-2 shall be furnished with 3/4", 1" or 1-1/2" wide slots as indicated in the drawings. Linear diffusers shall be 1-slot, 2-slot, 3-slot or 4-slot arrangement, and 24", 30", 36", 48" or 60" in length as shown on the drawings. Slot edges shall be double thickness 'hemmed' configuration.

Linear diffuser shall be suitable for rigid or flexible supply duct connection and for installation in a hard ceiling, or a lay-in T-bar, splined or regressed ceiling grid system. Provide a gasket edged blade in each slot to provide 180° adjustment of the discharge direction from the face of the diffuser.

Furnish linear diffusers with factory installed T-bars and T-bar mounting clips. Furnish each diffuser with a factory fabricated, and internally insulated supply plenum for round or oval duct connections of quantity and size as shown on the drawings. Diffusers and supply plenum shall be steel construction with extruded aluminum blade and vinyl blade gasket.

The total combined height of the diffuser and supply plenum shall not exceed 12". The plenum shall be furnished with a coated mill finish. The gasket edged blade shall be provided with a black baked enamel finish. The T-bars shall be furnished with a white baked enamel finish.

Provide center notch for T-bar where 48" long linear diffusers are installed in two 24" ceiling modules. Furnish diffusers suitable for straddle mounting of T-bars where indicated on drawings. Provide plaster mounting frame for each diffuser installed in hard ceiling construction. The mounting frame shall be 1-1/2" high and 1" wide. The diffuser shall be installed on the inside lip of the mounting frame.

Manufacturers:

Titus: TBD-80
E.H. Price: TBD-4
Nailor Industries

Linear Supply Diffusers LSD-3 shall be high induction, wide spread type with single slot configuration. The diffusers shall provide airflow in two separate discharge patterns. A horizontal discharge pattern shall be delivered from each end of diffuser through aerodynamically shaped fixed discharge slots.

Vertical discharge pattern shall be delivered from the center of diffuser through a Modulinear 'Ice-Tong' type pattern controller. The pattern controllers shall be furnished in 8", 12", 15" or 18" lengths as indicated on the drawings.

The horizontal discharge slots shall blanket the ceiling for air distribution throughout the room. The vertical discharge slot shall project a uniform sheet of air downward over the surface of a window or exterior wall. The center pattern controller shall provide 180° adjustment of the discharge direction, and volume control from the face of the diffuser.

Linear diffuser shall be suitable for rigid or flexible supply duct connection and for installation in a lay-in T-bar ceiling grid system. Furnish each diffuser with a factory fabricated, and externally insulated supply plenum for round or oval duct connections of quantity and size as shown on the drawings. Diffusers and supply plenum shall be steel construction with extruded aluminum pattern controllers.

The total combined height of the diffuser and supply plenum shall not exceed 8-3/8". The plenum shall be furnished with a coated mill finish. The diffuser shall be furnished with a black baked enamel finish.

Manufacturers:

Titus: N-D Series
E.H. Price: TBDV-3
Nailor Industries

GRILLES

Linear Return Grilles LRG-1 shall be furnished with 1/2", 3/4" or 1" wide slots as indicated in the drawings. Linear diffusers shall be 1-slot, 2-slot, 3-slot or 4-slot arrangement, and 24" or 48" in length as shown on the drawings. Slot edges shall be double thickness 'hemmed' configuration.

Linear return grilles shall be suitable for installation in a lay-in T-bar ceiling grid system, or a hard ceiling system. Furnish linear grilles with factory installed T-bars and T-bar mounting clips. Furnish each return grille with light shield. Linear return grilles and light shield shall be steel construction.

The total combined height of the grille and light shield shall not exceed 11". The light shield shall be furnished with a coated mill finish. The interior of the unit shall be provided with a black baked enamel finish. The T-bars shall be furnished with a white baked enamel finish.

Provide center notch for T-bar where 48" long linear return grilles are installed in two 24" ceiling modules. Furnish grilles suitable for straddle mounting of T-bars where indicated on drawings. Provide plaster mounting frame for each grille installed in hard ceiling construction. The mounting frame shall be 1-1/2" high and 1" wide. The grille shall be installed on the inside lip of the mounting frame.

Manufacturers:

Titus: TBDR-30

E.H. Price: TBDR-3

Nailor Industries

Linear Return Grilles LRG-2 shall be furnished with 3/4", 1" or 1-1/2" wide slots as indicated in the drawings. Linear grilles shall be 1-slot, 2-slot, 3-slot or 4-slot arrangement, and 24", 36", 48" or 60" in length as shown on the drawings. Slot edges shall be double thickness 'hemmed' configuration.

Linear grilles shall be suitable for installation in a hard ceiling, or a lay-in T-bar, splined or regressed ceiling grid system. Furnish linear grilles with factory installed T-bars and T-bar mounting clips. Furnish each return grille with light shield. Linear return grilles and light shield shall be steel construction.

The total combined height of the grille and light shield shall not exceed 11". The light shield shall be furnished with a coated mill finish. The interior of the unit shall be provided with a black baked enamel finish. The T-bars shall be furnished with a white baked enamel finish.

Provide center notch for T-bar where 48" long linear return grilles are installed in two 24" ceiling modules. Furnish grilles suitable for straddle mounting of T-bars where indicated on drawings. Provide plaster mounting frame for each grille installed in hard ceiling construction. The mounting frame shall be 1-1/2" high and 1" wide. The grille shall be installed on the inside lip of the mounting frame.

Manufacturers:

Titus: TBDR-80

E.H. Price: TBDR-4

Nailor Industries

Return Grilles RG-1 shall be steel construction and rectangular configuration. Provide one set of fixed blades parallel to the long dimension. Grilles for lay-in ceiling installation shall be furnished with Titus type 3 borders. Grilles for installation in walls or hard ceilings shall be furnished with Titus type 1 border for surface mounting.

Blades shall be spaced 3/4" on centers with 45° deflection. Secure overlapping frame of grille to inverted duct collar, wall or ceiling construction with oval head, countersunk screws. Screw heads shall be enameled to match the border. Finish for registers shall be off-white baked enamel.

Manufacturers:

Titus: 23RL
E.H. Price: 530
Carnes Co.: RSLA
Nailor Industries

Exhaust Grilles EG-1 shall be steel construction and rectangular configuration. Provide one set of fixed blades parallel to the long dimension. Grilles for lay-in ceiling installation shall be furnished with Titus type 3 borders. Grilles for installation in walls or hard ceilings shall be furnished with Titus type 1 border for surface mounting.

Blades shall be spaced 3/4" on centers with 45° deflection. Secure overlapping frame of grille to inverted duct collar, wall or ceiling construction with oval head, countersunk screws. Screw heads shall be enameled to match the border. Finish for grilles shall be off-white baked enamel.

Manufacturers:

Titus: 23RL
E.H. Price: 530
Carnes Co.: RSLA
Nailor Industries

Return Grilles RG-1 shall be steel construction and rectangular configuration. Provide one set of fixed blades parallel to the long dimension. Provide Titus type 1 border for surface mounting in wall construction.

Blades shall be spaced 1/2" on centers with 0° deflection. Secure overlapping frame of grille to wall construction with oval head, countersunk screws. Screw heads shall be enameled to match the border. Finish for registers shall be off-white baked enamel.

Manufacturers:

Titus: 15RL
E.H. Price: 510L
Carnes Co.: GSE
Nailor Industries

Transfer Grilles TG-1 shall be provided on each side of the wall construction as shown on the drawings. Grilles shall be steel construction and rectangular configuration. Provide one set of fixed blades parallel to the long dimension. Provide Titus type 1 border for surface mounting in wall construction.

Blades shall be spaced 3/4" on centers with 35° deflection. Secure overlapping frame of grille to wall construction with oval head, countersunk screws. Screw heads shall be enameled to match the border. Finish for registers shall be off-white baked enamel.

Manufacturers:

Titus: 350RL
E.H. Price: 530L
Carnes Co.: RSLA
Nailor Industries

Security Grilles SG-1 shall be provided where shown on the drawings. Grilles shall be 14 gauge steel construction, rectangular configuration, with bar type face.

Grille face shall be stitch welded to the grille sleeve and shall have a 1" face flange. Grille blades shall be 1/2" x 1/8" steel bars on 1/2" centers. Blades shall penetrate the supports and shall be welded to grille sleeve. Supports shall be 14 gauge steel supports at 6" on center (maximum), stitch welded inside the sleeve. Provide10 gauge (0.135" diameter wire) x #2 mesh (1/2" centers) screen behind face of security grille. Finish shall be off-white baked enamel.

Where indicated on drawings, provide integral fire damper with security grille.

Where indicated on drawings, provide integral balancing damper with security grille.

Where indicated on drawings, provide aluminum or stainless steel construction and finish.

Manufacturers:

Kees: SEG-5
E. H. Price
Titus
Nailor Industries

Security Grilles SG-2 shall be provided where shown on drawings. Provide duct security bars with 1/2" diameter welded security bars at 6" maximum spacing on center in horizontal and vertical direction, with no vertical or horizontal space exceeding 6". Duct Security bars shall be welded to 10-gauge steel frame (minimum). Duct security bar assembly shall be constructed of galvanized steel.

Install duct security bars integral to ductwork at all secure boundary locations. Duct access doors shall be located on the secure side of the duct security bars and positioned so that the Owner can easily observe the presence of the duct security bars.

Manufacturers:

Ruskin
Nailor
Titus
E.H. Price
Kees

OUTSIDE LOUVERS

Louvers shall be 4" deep, drainable, extruded aluminum with stationary blades. Frame and blade thickness shall be not less than 0.081". Louver assembly shall be constructed and reinforced with structural supports to withstand wind velocities up to 90 MPH without damage.

Each louver blade shall be extruded with drain gutter at bottom of blade, and each blade shall drain into integral downspout in side frames and intermediate mullions. Louvers shall be furnished with framed removable 3/4" x .051" expanded flattened aluminum bird screen attached to back side of louvers.

Free area velocity through the louvers shall not exceed 800 FPM for overall size shown and for the full air quantity shown for the air handler unit or fan. The pressure drop through the louver shall not exceed 0.1" W.C. at 800 FPM free area velocity.

Louvers shall have water penetration not to exceed 2.5 oz. of water per sq. ft. (by weight) in 15 minutes at free area velocity of 800 FPM and at rainfall rate of 4 inches per hour. The ratings shall be based on tests made in accordance with AMCA Standard 500 and shall comply with the requirements of the AMCA Certified Ratings Program. The louver manufacturer shall submit certified copies of the tests, for the type of louvers proposed, showing water penetration for the sizes indicated on drawings.

Louvers installed in masonry or concrete walls shall have box channel frame. Louvers installed in framed openings shall have flanged frame. Louvers shall be furnished with caulking slots and installed airtight in the wall opening. Louvers shall be caulked all around with silicone based caulking compound. Verify the size of louver and the opening into which the louver will be installed before ordering.

Seal frame to insure water tight conditions. Seal lower half of connecting ductwork with mastic and pitch so water will drain out through the frame. The louver shall have anodized bronze finish of color shade as selected by the Architect. Submit anodize finish color charts with shop drawings.

Manufacturers:

Ruskin Mfg. Co.: ELF81S

Arrow Louver and Damper Corp.: SPA11

Construction Specialties, Inc.: 4115

All louvers shall be factory primed and painted with color as selected by the Architect from the manufacturer's full range of Kynar 500 finish coating or equal and include insect screen accessories.

EXECUTION

INSPECTION

Visit job-site prior to installation to verify all conditions, connections, and instruction to all parties with regard to shop drawings. Starting work means acceptance of other in-place work.

Before installation, inspect building dimensions and rough-in, including means of access, for conditions affecting delivery and installation.

Before work is installed, Architect/Engineer reserves right to make modifications to location of items to provide satisfactory coordination between Contractors.

Provide inserts and anchors built into other work for support of this work.

Ensure these items are installed in their proper location.

Include fastening devices to attach work.

Use proper anchoring devices for materials encountered and usage expected.

METHOD OF INSTALLATION

Install grilles, registers, diffusers, louvers, hoods and accessories in accordance with manufacturer's instructions using workers skilled and familiar with items and installation specifications and procedures.

Sequence installation and erection to ensure work is affected in orderly and expeditious manner. Do cutting, fitting and patching, coordinating work fully with other crafts involved. Locate all ceiling mounted grilles, registers and diffusers according to Architectural reflected ceiling drawings.

START-UP, TESTING AND TRAINING

Clean, test, balance and adjust equipment prior to start-up to ensure systems are operational and complete in all respects, including all accessories. Testing and balancing specified in Section 230593.

END OF SECTION 233713

SECTION 235216 - CONDENSING BOILERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged, factory-fabricated and -assembled, gas-fired, pulse-combustion condensing boilers, trim, and accessories for generating hot water.

1.2 SUBMITTALS

A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.

1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.
    a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
    b. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails and equipment mounting frames.
2. Wiring Diagrams: Power, signal, and control wiring.

C. Manufacturer Seismic Qualification Certification: Submit certification that boiler, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Operation and maintenance data.

G. Warranty: Special warranty specified in this Section.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."

E. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Pulse-Combustion Boilers:

a. Pressure Vessel Thermal Shock: 10 years (non pro-rated)
b. Pressure Vessel Material/Workmanship Defects: 10 years (prorated after year 7)
c. Heat-Exchanger Corrosion: 10 years from date of Substantial Completion (pro-rated after year 7)
d. Pressure
e. All Parts warranty for 18 months from shipment or 12 months from start-up, whichever comes first

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Fulton Boilers – Pulse.
2. Aerco – Benchmark.
3. Lochinvar – Crest.

2.2 MANUFACTURED UNITS

A. Description: Factory-fabricated, -assembled, and -tested, pulse-combustion condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls.

B. Heat Exchanger: SA-790 Grade 2205 Duplex Alloy Steel Combustion Chamber Flue Pipes.

C. Pressure Vessel: Carbon steel with welded heads and tube connections, and shall be fully insulated with 2” of high temperature insulation. Jackets shall be insulated with ¼” thick high density board insulation with an internal heat reflective coating.

D. The Heads shall be SA-516 Grade 70 plate

E. Exhaust Decoupler: Shall be constructed of a ¼” corrosion resistant Corten alloy and include a flue gas condensate drain connection.

F. Burner: Natural gas, self-aspirating and self-venting after initial start.

G. Blower: Centrifugal fan to operate only during start of each burner sequence.

1. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

H. Gas Train: CSD-1 Code Compliant, Integral, Factory Assembled and Installed. One manual shut-off valve at gas inlet, gas inlet trap, gas regulator rated for max 14” WC supply pressure, two safety shut-off valves (one to be solenoid and one to be motorized), and independent low and high gas pressure switched shall be supplied.

I. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.

J. Casing:

1. Jacket: Sheet metal, with snap-in or interlocking closures.
2. Control Compartment Enclosure: NEMA 250, Type 1A.
3. Finish: Baked Enamel
4. Insulation: Minimum 2-inch thick, mineral-fiber insulation surrounding the heat exchanger.
5. Combustion-Air Connection: Inlet duct collar and sheet metal closure over burner compartment.
6. Secure boiler to concrete base using vibration isolation spring mounts with a 1” deflection

K. Mufflers: Carbon-steel intake muffler and stainless-steel exhaust.

L. Design:

1. The water flow pressure drop through the boiler shall not exceed 10 FT @ 125 GPM.
2. The boiler shall not require flow switches or other devices to insure a minimum flow through the boiler.

2.3 TRIM

A. Include devices sized to comply with ANSI B31.9, "Building Services Piping"

B. Safety Relief Valve: ASME rated.

C. Pressure and Temperature Gage: Minimum 3-1/2-inch diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and temperature ranges so normal operating range is about 50 percent of full range.

D. Drain Valve Assembly: To be factory supplied by the boiler manufacturer for field installation.

E. Condensate Drain Kit: To be factory supplied by the boiler manufacturer for field installation.

F. Circulation Pump: Boiler must have no minimum flow requirements and thus must not require a boiler circulating pump.

G. Condensate neutralization kit to be supplied by the boiler manufacturer for field installation.

2.4 CONTROLS

A. Refer to Division 23 Section "Instrumentation and Control for HVAC."

B. Boiler operating controls shall include the following devices and features:

1. Microprocessor based sequencing/monitoring controller with a graphical user interface and touchscreen capabilities. To be provided by the boiler manufacturer.
    a. The active touchscreen display area will be a minimum of 5.7” with a Full Color TFT display resolution
    b. The boiler sequencing system enclosure will be NEMA 4X construction
    c. The boiler sequencing system will be wall mounted and a stand-alone unit.
    d. Boilers with local integral lead/lag controllers will not be acceptable due to limited logic capabilities
2. The sequencing system shall monitor the outdoor temperature and calculate a hydronic loop temperature setpoint based on touchscreen selectable user-defined values. The sequencing system will stage operation of the hydronic boilers based on the difference between the actual hydronic loop temperature and the calculated (outdoor air reset) hydronic loop temperature setpoint.
3. The following sensors shall be provided with the boiler sequencing system: Outdoor Temperature Sensor, Supply Header Temperature Sensor and Two (2) Return Water Temperature Sensors.
4. The boiler sequencing system shall provide the following screens at a minimum:
    a. Outdoor Reset Configuration
    b. Setback Schedule
    c. Lead/Lag Configuration
    d. Boiler Configuration
    e. System Status
    f. Alarm Status
    g. Alarm History

5. The boiler sequencing system shall provide Outdoor Reset Configuration Screens that include all of the parameters required to effectively configure the hydronic loop setpoint based on the outdoor temperature.
6. The boiler sequencing system will stage the boilers based on a PID generated control variable value. These values shall be user definable.
7. The boiler sequencing system shall include Alarm History that allows for the last 100 alarms to be displayed, with a date/time stamp and text description.
8. Trending of the supply temperature, system setpoint and outdoor temperature will be displayed to provide system operational history for tuning of the PID and leag/lag parameters.
9. The boiler sequencing system shall have the ability to communicate to a building managements system:

    a. Required protocol, BACNet. Interface factory installed in the boiler sequencing controller wall-mounted panel

C. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

1. High Limit Temperature Control with Manual Reset
2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual -reset type.
3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
4. Flame sensing by pressure switches and flame rod
5. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

2.5 ELECTRICAL POWER

A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

1. Boiler shall only require a 120/60/1 connection
2. Maximum Amp Draw: 4.2 FLA
3. House in NEMA 250 Enclosure
4. Wiring shall be numbered and color-coded to match wiring diagram.
5. Install factory wiring outside of an enclosure in a raceway.
6. Field power interface shall be to wire lugs on terminal block
7. Provide each motor with overcurrent protection.

2.6 VENTING KITS

A. Kit: Complete system, ASTM A 959, Type AL29-4C stainless steel, double wall construction, pipe, vent terminal, thimble, indoor plate, vent adapter, and sealant.

B. Combustion-Air Intake: Complete system, PVC, pipe, vent terminal with screen, inlet air coupling, and sealant.

2.7 SOURCE QUALITY CONTROL

A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

C. Emissions: The boiler shall operate with CO emissions less than 100 PPM corrected to 3% O2 and shall operate with NOx emissions less than 55 PPM corrected to 3% O2 over the entire turndown range.

PART 3 - EXECUTION

3.1 BOILER INSTALLATION

A. Install boilers level on concrete base. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.

B. Vibration Isolation: Vibration Spring Isolator Mounts with a 1” Minimum Deflection. Vibration isolation devices and installation requirements are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

C. Install gas-fired boilers according to NFPA 54.

D. Assemble and install boiler trim.

E. Install electrical devices furnished with boiler but not specified to be factory mounted. To include wall mounted boiler sequencing panel, to be wired to each boiler with twisted pair daisy chain wiring.

F. Install control wiring to field-mounted electrical devices.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to boiler to allow service and maintenance.

C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Division 23 Section "Common Work Results for HVAC."

E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.

F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.

G. Install piping from safety relief valves to nearest floor drain.

H. Boiler Venting:

1. Install flue venting kit and combustion-air intake.
2. Connect full size to boiler connections. Comply with requirements in Division 23 Section "Breechings, Chimneys, and Stacks."

I. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

J. Connect wiring according to Division 26 Section "Low-Voltage Electrical Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Perform installation and startup checks according to manufacturer's written instructions.
2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
    a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.
    b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Remove and replace malfunctioning units and retest as specified above.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Include 8-hour (or as required) block onsite for boiler functional performance tests, training, boiler controls, and DDC interlocks.

B. As part of the warranty period, the manufacturer shall provide support services for owner for a period of 2-years.

END OF SECTION 235216

SECTION 235700 - HEAT EXCHANGERS

GENERAL

DESCRIPTION OF WORK

Shell and tube heat exchangers

Plate & Frame Heat exchangers

RELATED DOCUMENTS

American Society for Mechanical Engineers, ASME:

Section 8D: Pressure Vessels

QUALITY ASSURANCE

SUBMITTALS

Submit in accordance with Division 1.

Product Data:

Include dimensions, locations, size of taps, performance data, and manufacturer's installation instructions.

Certificate:

Submit manufacturer's certificate that heat exchangers meet or exceed specifications.

Reports:

Submit test reports of tube bundle pressure tests.

Operation and Maintenance Data:

Submit operation and maintenance data.

Include start-up and shut-down instructions, assembly drawings, and spare parts lists.

EQUIPMENT

SHELL AND TUBE HEAT EXCHANGER

Materials:

Provide shell and tube heat exchanger with capacities as scheduled on drawings.

Tubes shall be U-tube type with 3/4 inch O.D. minimum seamless copper tubes, suitable for 125 psig working pressure.

Shell shall be Steel with threaded or flanged piping connections and taps. Furnish and install steel saddle and attaching U-bolts, prime coated.

Heads shall be Cast-iron or fabricated steel with steel or bronze tube sheets threaded or flanged for piping connections. Water chamber and tube bundle shall be removable for inspection and cleaning.

Install heat exchangers in accordance with manufacturer's installation instructions. Installation shall permit removal of tube bundle without disturbing installed equipment or piping. Support heat exchangers on welded steel pipe and angle floor stand. Pitch shell to completely drain condensate. Pipe relief valves and drain valves to nearest floor drain. Contractor shall provide two sets of replacement gaskets to Owner.

Accessories:

Controls:

Manufacturers:

Armstrong

Dunham-Bush, Inc.

Harsco Corp.

Bell & Gossett

WATER-TO-WATER HEAT EXCHANGER TRIM

Material:

Provide on the heating water inlet (Downstream of Control Valve), ASME rated pressure and temperature relief valve.

Provide on water inlets and outlets thermometer wells and pressure gauges.

Provide on heated water outlet thermometer well for temperature regulator sensor, ASME rated pressure and temperature relief valve, piped to nearest floor drain unless noted otherwise on drawings.

Accessories:

Controls:

Manufacturers:

EXECUTION

METHOD OF INSTALLATION

Install in accordance with manufacturer's installation instructions.

Install permitting removal of tube bundle without disturbing installed equipment or piping.

Support heat exchangers on welded steel pipe and angle floor stand unless indicated otherwise on drawings.

Pitch shell to completely drain condensate.

Pipe relief valves and drain valves to nearest floor drain.

INSPECTION

TESTING

START-UP

TRAINING

END OF SECTION

SECTION 23 61 00 – RADIANT FLOOR HEATING SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Radiant floor heating and snow melting systems for various applications and control strategies, using PEX-Aluminum-PEX (PAP) tubing and appropriate fittings.
B. See on drawing details for components, equipment, piping, and materials. System for this project shall include the following:
   1. DIH series injection mixing with outdoor reset zone control panel. This shall have three zones, control panel for integration, sensor connections, piping temperature sensor connections, outdoor air temperature sensor connection, etc. Each pump shall be capable of 25 feet of head at 7 GPM.
   2. Three manifolds (1 for each zone), model ZB-N-# of circuits per plan. No. of circuits shall be 8-10 per plan, and manifold shall be in cabinet.
   3. 1/2" Tubing below grade from manifolds equal to Watts RadiantPEX-AL or 5/8" ONIX.
   4. Fittings for tubing, connections to welded-wire-fabric/rebar, sweep forms / bend supports for 180 deg and 90 deg turns, compression tools,

1.2 RELATED SECTIONS

A. Section 02551 – Underground Hydronic Piping

B. Section 03300 – Concrete

C. Section 06100 – Rough Carpentry

D. Section 07210 – Insulation

E. Section 15093 – Sleeves and Sleeve Seals for HVAC Piping

F. Section 15181 – Hydronic Piping

1.3 REFERENCES

A. General: Standards listed by reference, including revisions by issuing authority, form a part of this specification section to the extent indicated. Standards listed are identified by issuing authority, authority abbreviation, designation number, title or

other designation established by issuing authority. Standards subsequently referenced herein are referred to by issuing authority abbreviation and standard designation.

B. ASTM International:
   1. ASTM F1281 Standard Specification for Cross-linked Polyethylene/Aluminum/Cross-linked Polyethylene (PEX/AL/PEX) Pressure Pipe
   2. ASTM F1335 Standard Specification for Pressure-Rated Composite Pipe for Elevated Temperature Service

C. Certified to International Association of Plumbing and Mechanical Officials (IAPMO) by NSF:
   1. Uniform Mechanical Code (UMC)

D. Watts Radiant
   1. RadiantPEX, RadiantPEX+, and RadiantPEX-AL Installation Manual
   2. RadiantWorks Professional Software

1.4 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Cross-linked Polyethylene-Aluminum-Cross-linked Polyethylene Composite Pipe (PAP): Standard Grade hydrostatic pressure ratings. The following four standard-grade hydrostatic ratings are required:
      a. 200 degrees F (93 degrees C) at 100 psi (689 kPa).
      b. 180 degrees F (82 degrees C) at 125 psi (862 kPa).
      c. 140 degrees F (60 degrees C) at 160 psi (1102 kPa).
      d. 73.4 degrees F (23 degrees C) at 200 psi (1379 kPa).

B. Performance requirements: Provide Hydronic system that is manufactured, fabricated and installed to comply with regulatory agencies and authorities with jurisdiction, and maintain performance criteria stated by the tubing manufacturer without defects, damage, or failure.
   1. Cross-linked Polyethylene-Aluminum-Cross-linked Polyethylene Composite Tubing (PAP):
      a. Show compliance with ASTM F1281

1.5 SUBMITTALS

A. General: Submit listed submittals in accordance with Conditions of the Contract and Division 1 Submittal Procedures Section.
B. Product Data: Submit manufacturer’s product submittal data and installation instructions for each product.

C. Shop Drawings – Hydronic System
   1. Provide engineering analysis using manufacturer's proprietary software.
   2. Provide installation drawings indicating tubing layout, manifold locations, zoning requirements, and manifold schedules with details required for installation of the system.
   3. Provide mechanical schematic indicating heat source, mechanical piping and accessories from heat source to manifolds, circulators, water tempering, and zone controls. Indicate supply water temperatures and flow rates to manifolds.

D. Samples: Submit selection and verification samples of primary materials.

E. Documentation:
   1. Provide manufacturer's detailed instructions for site preparation and product installation.
   2. Provide manufacturer's electrical power requirements and heat output in watts delivered to the structure.
   3. Provide documentation indicating the installer is trained to install the manufacturer's products, as needed.

F. Quality Assurance and Control Submittals:
   1. Upon request, submit test reports from recognized testing laboratories.

G. Closeout Submittals – Submit the following:
   1. Warranty documents specified
   2. Operation and maintenance data
   3. Manufacturer's field reports as specified in this document
   4. Final as-built tubing layout drawing

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Manufacturer shall have a minimum of ten years experience in similar systems.
   2. Manufacturer shall provide products of consistent quality in appearance and physical properties.
   3. Manufacturer shall use the highest quality products in the production of systems and components referenced in this document.
   4. Materials shall be from a single manufacturer to ensure consistent quality and compatibility.

B. Installer Qualifications:
   1. Use and installer with demonstrated experience on projects of similar size and complexity and/or documentation proving successful completion of familiarization training hosted/approved in writing by the system manufacturer.
   2. Electrical rough-in and connections shall be done by a licensed electrician.

C. Certifications: Provide letters of certification as follows:
   1. Installer employs skilled workers holding a trade qualification license or equivalent, or apprentices under the supervision of a licensed trades person.

D. Regulatory Requirements and Approvals – Hydronic Systems: Provide a radiant system that complies with the following requirements:
   1. International Code Council (ICC):
      a. International Mechanical Code (IMC)
      b. International Building Code (IBC)
      c. ICC Evaluation Service (ES) Evaluation Report No. ESR 1155
   2. International Association of Plumbing and Mechanical Officials (IAPMO):
      a. Uniform Mechanical Code (UMC)

E. Pre-installation meetings
   1. Verify project requirements, substrate conditions, excavation conditions, system performance requirements, coverings, manufacturer’s installation instructions, and warranty requirements.
   2. Review project construction timeline to ensure compliance or discuss modifications as required.
   3. Coordinate with other trade representatives to verify areas of responsibility.
   4. Establish the frequency (during construction phase of the project) the engineer intends for site visits and inspections by the manufacturer’s representative.

F. Mock-up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
   1. Finish areas designated by Architect
   2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
   3. Refinish mock-up area as required to produce acceptable work

1.7 DELIVERY, STORAGE, AND HANDLING

A. General: Comply with Division 1 Product Requirements Section.

B. Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.

C. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

D. Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer:
   1. Store tubing in cartons or under cover to avoid dirt or foreign material from entering the tubing.
   2. Do not expose tubing to direct sunlight for more than 30 days. If construction delays are encountered, cover the tubing that is exposed to direct sunlight.

1.8 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

B. Morter-set Systems: Mortar shall cure for 25 days (or time specified by mortar manufacturer) prior to starting heating systems.

1.9 WARRANTY

A. Project Warranty: Refer to Conditions of the Contract for project warranty provisions.

B. Manufacturer's Warranty – Hydronic Systems
   1. Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official.
   2. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under contract documents.
      a. Warranty covers the repair or replacement of any tubing or fittings proven defective.
      b. Warranty may transfer to subsequent owners.
      c. Warranty Period for Tubing is 25-year, non-prorated warranty against failure due to defect in material or workmanship, beginning with date of substantial completion.

d. Warranty Period for Manifolds and Fittings is 2-year, non-prorated warranty against failure due to defect in material or workmanship, beginning with date of substantial completion.
e. Warranty period for Controls and Electrical components is a 2-year, non-prorated warranty against failure due to defect in material or workmanship, beginning with date of substantial completion.

1.10 SYSTEM START-UP

A. Do not start the system for a minimum of 25 days or as specified by mortar, concrete and/or covering manufacturer as applicable.

B. Verify all electrical components are installed per local and National Electrical Code (NEC) prior to start-up.

1.11 OWNER'S INSTRUCTIONS

A. Instruct Owner about operation and maintenance of installed system.

B. Provide Owner with manufacturer's installation instructions for installed components within the system.

C. Provide Owner with all operating instructions/documents for sensors and controls.

D. Provide Owner with copies of any detailed layout drawings and photos of installed product before coverings are installed.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer:

Watts Radiant, Inc.

(Subsidiary of Watts Water Technologies, Inc.)

4500 E. Progress Place

Springfield, MO 65803

(800) 276-2419; (417) 864-6108; Fax: (417) 864-8161

Web: http://www.wattsradiant.com

B. Substitutions: not permitted

2.2 PRODUCT CHARACTERISTICS

A. Material:

1. Cross-linked polyethylene with an aluminum middle core.
2. Manufactured by PEX-b or Silane method.

B. Material Standard:
   1. Manufactured in accordance with ASTM F1281.
   2. Tested for compliance by an independent third-party agency.

C. Temperature/Pressure Ratings: shall be capable of withstanding temperatures of:
   1. 73.4°F (23°C) at 160 psi (1.10 MPa)
   2. 180°F (82.2°C) at 100 psi (0.69 MPa)
   3. 200°F (93.3°C) at 80 psi (0.55 MPa).

D. Minimum Bend Radius (Cold Bending):
   1. No less than five times the outside diameter.
   2. Use the tubing manufacturer's bend supports if radius is less than stated.

E. Barrier Tubing Type: Watts Radiant RadiantPEX-AL:
   1. Oxygen Diffusion Barrier
      a. Tubing has an oxygen diffusion barrier that shall not exceed an oxygen diffusion rate of 0.006 g/cubic meter (0.000000375 lb/cu. ft.) per day at 104 degrees F (40 degrees C) water temperature in accordance with German DIN 4726.
   2. Nominal Inside Diameter: Provide tubing with nominal inside diameter in accordance with ASTM F876, as indicated:
      a. ½ inch (12.7 mm) nominal = 0.472 inch (12 mm)
      b. ⅝ inch (16 mm) nominal = 0.630 inch (16 mm)
      c. ¾ inch (20 mm) nominal = 0.787 inch (20 mm)
      d. 1 inch (25.4 mm) nominal = 0.984 inch (25 mm)

2.3 MANIFOLDS AND FITTINGS

A. Manifolds (Residential and light Commercial, Stainless Steel)
   1. For system compatibility, use 1 or 1½" (25 – 38mm) Stainless Stel manifolds offered by the respective tubing manufacturer.
   2. Manifolds shall provide individual flow control for each loop of the manifold through valve actuators available from the manifold supplier.
   3. Manifolds shall feature manual flow balancing capability within the manifold body for balancing unequal loop lengths across the manifold. Balance valves shall not be ball valves.
   4. Manifolds accommodate ½ - ¾" (12.7 – 19 mm)RadiantPEX-AL tubing.
   5. Each manifold location shall have the ability to vent air manually from the system.
   6. Stainless Steel 1" (25 mm) Manifolds
      a. Heavy-duty, DIN Standard, 304 stainless steel
      b. Matching fittings and accessories are made of solid brass and are heavily plated with nickel to match the appearance of the manifold trunk.
      c. Internal balancing valves
      d. 0 - 2½ gpm (0 – 0.16 L/sec)flow meters
      e. Manifold brackets
      f. All connections are BSP (British Standard Pipe) or straight thread and require the use of the included gasket.
      g. 2⅛" (54 mm) OC circuit spacing
      h. 12 gpm (.75 L/sec) maximum flow rate
      i. 194°F (90°C) maximum operating temperature
      j. 87 psi (600 kPa) maximum operating pressure
      k. 2½ gpm (0.16 L/sec) per circuit maximum flow rate
   7. Stainless Steel 1½" (38 mm) Manifolds
      a. Heavy-duty, DIN Standard, 304 stainless steel
      b. Matching fittings and accessories are made of solid brass and are heavily plated with nickel to match the appearance of the manifold trunk.
      c. Internal balancing valves

d. 0 - 4 gpm (0 – 0.25 L/sec)flow meters
e. Manifold brackets
f. All connections are BSP (British Standard Pipe) or straight thread and require the use of the included gasket.
g. 2⅛” (54 mm) OC circuit spacing
h. 22 gpm (1.4 L/sec) maximum flow rate
i. 194°F (90°C) maximum operating temperature
j. 87 psi (600 kPa) maximum operating pressure
k. 4 gpm (0.25 L/sec) per circuit maximum flow rate

B. Manifolds (Commercial, Copper)
1. Provide 1” (25 mm) or larger Copper manufactured from L-copper and offered by the respective tubing manufacturer for system compatibility.
a. Install manifolds with optional isolation valves located on both the supply and return manifold.
b. Each manifold location shall have the ability to vent air manually from the system.
2. Provide Copper manifolds approved for use in systems free of ferrous materials, or isolate ferrous material to eliminate corrosion damage due to oxygen diffusion.
3. Balancing:
a. Design individual loop lengths across the manifold with 10% of each other in length.
b. Install supply and return piping to the manifold in a reverse-return configuration to ensure self-balancing.
c. Where the supply and return piping is in direct-return configuration, use manifolds with balancing valves or balance flow setters on the return leg of each manifold to the mains.

C. Manifold Mounting Boxes
1. Sizes – Watts Radiant manifold mounting boxes come in 3 sizes:
a. 15¾” by 28½” by 4¼” (400mm by 724 mm by 108 mm)
b. 24½” by 28½” by 4⅜” (622mm by 724 mm by 111 mm)
c. 39½” by 28½” by 4⅜” (1003mm by 724 mm by 111 mm)
2. Each box shall be designed to be recessed into a 4” or 6” (102 mm or 152 mm) stud wall.
3. Included elevators can raise the box from 1½” to 4½” (38 – 114 mm) off of the floor.
4. Each manifold box is constructed of powder-coated sheet metal, providing increased resistance to corrosion and job-site abuse.
5. Inside Manifold Mounting Brackets:
a. Manifold boxes come with 2 fixed horizontal attachment rails and 2 adjustable rails.
b. Each Watts Radiant manifold option will utilize different rail positions, depending on the bracket used.

D. Fittings
1. For system compatibility, use fittings offered by the tubing manufacturer.
a. The fitting assembly shall comply with ASTM F1281.

b. Only Watts Radiant RadiantPEX-AL stainless steel Press Fittings or Compression Fittings are approved.
c. Available connections:
    1) Sweat
    2) NPT
    3) BSP

2.4 SUPPLY AND RETURN PIPING

A. Supply-and-Return Piping to the Manifolds (above ground piping):
    1. Properly size supply and return distribution piping for the given volume and velocities required at system design.
    2. Use compatible distribution pipe material for all supply fluid temperatures and flows in systems with ferrous components.
        a. When using Watts Radiant RadiantPEX-AL tubing, do not exceed 200 degrees F (93 degrees C) at 100 psi (689 kPa).
    3. Do not expose Watts Radiant RadiantPEX-AL tubing to direct sunlight.
        a. Where PEX tubing is exposed, install suitable pipe insulation around the exposed tubing.
    4. Use fittings compatible with piping material. Fittings shall transition from distribution piping to system manifolds.

B. Supply and Return Piping to the Manifolds (below ground piping):
    1. Properly size supply and return distribution piping for the given volume and velocities required at system design.
    2. Use suitable distribution piping material for all supply fluid temperatures and flows in systems with ferrous components.
        a. When using Watts Radiant RadiantPEX-AL tubing, do not exceed 200 degrees F (93 degrees C) at 100 psi (689 kPa).
    3. Use fittings compatible with piping material. Fittings shall transition from distribution piping to system manifolds.

2.5 ROOM TEMPERATURE CONTROLS

A. Room Temperature Controls:
    1. Thermostat: DualTemp, air/floor, digital, 24V
    2. Thermostat: DualTemp, air/floor, digital, battery
    3. Thermostat: DualTemp, air/floor, non-digital, 24V
    4. Thermostat: Digital, programmable, air, 24V
    5. All thermostats shall operate within a one degree differential temperature incorporating pulse-width modulation action.
    6. Install a Watts Radiant Thermostat (heat only) with digital display in each room or zone as required.
        a. The Watts Radiant DualTemp thermostat shall have the ability to sense the temperature of the air, floor, or a combination of air and floor.
        b. Each DualTemp shall be equipped with an internal air sensor.

7. For multiple-zoning control, install the loop(s) per zone and install the individual valve actuators on the respective loop(s) at the manifold.
    a. Electro-thermal Actuators
        1) Watts Radiant Thermal Actuators are a four-wire actuator designed for use with Watts Radiant Stainless Steel manifolds.
            (a) Actuators are normally closed and will open when power is applied.
            (b) Actuators shall consume no more than 2.5 watts.
            (c) Travel time for the actuators is approximately 90 seconds to close the end switch.
            (d) Each actuator consists of 4 wires, 2 for poser and 2 for an end switch.
    b. Zone Valve Actuator Control Module: Zone valve actuator controls operate zone valves or circuit thermal actuators by supplying 24VAC.
        1) No more than three 2.5 VA actuator valves can be connected to any single zone terminal block.
        2) The control system shall be designed for use with the following models of thermostats:
            (a) Watts Radiant DualTemp (3 or 4 wire)
            (b) Watts Radiant Air Only thermostats
            (c) Use only Watts Radiant non-programmable thermostat if using Optional Timer
            (d) Any 2 wire thermostats with internal battery poser
            (e) 2 wire thermostats that consume poser shall not be used, as damage to either the thermostat or controller may occur.
                (1) Never connect a power consuming 2 wire thermostat to the control as damage to the thermostat and/or control may occur.
        3) External 24/120 VAC transformer (not included) is required to operate these controls.
            (a) A 40 VA transformer for a maximum of 12 actuators
            (b) A 60 VA transformer for a maximum of 18 actuators
        4) Master Controls:
            (a) Equipped with valve and thermostat terminals
            (b) Incoming 24 volt power connection
            (c) Two 8 amp, dry contact terminals for pump and boiler operation
                (1) With end-switch capability, the Zone Control Module activates other relays or controls as required by system control strategy.
                (2) Control does not use the end-switch wires of a 4 wire actuator
                (3) Both 2 wire and 4 wire actuators may be used.
        5) Slave Controls:
            (a) The use of Slave units allows the control of more zones utilizing the same pump and boiler.
            (b) Up to 2 Slave controls can connect to a Master
                (1) Allows for a maximum of 18 separate zones or thermostat connections
                (2) Both 2 wire and 4 wire actuators may be used.

2.6 HYDRONIC RADIANT SNOW MELTING CONTROLS

A. Use sensors/controls provided by manufacturer:
    1. HSC-5 Snow Melting Slab Detector

a. Slab / Pavement mounted
b. Senses actual pavement conditions
c. Microprocessor control eliminates ice-bridging
d. Provides a low-amperage output relay contact
e. Heavy-duty machined brass housing
f. Removable top cover
g. Plug-in electronic assembly
h. 24 VAC

2. LCD-1H Automatic Snow Switch
   a. Pole-mounted
   b. Senses both temperature and precipitation
   c. Isolated 3 Amp resistive/1 Amp inductive relay contact
   d. 24 VAC

2.7 ACCESSORIES

A. Provide accessories associated with the installation of the radiant heating system as recommended by or available from the tubing manufacturer.
   1. IsoTherm: The IsoTherm provides mixing control and zone pumping all in a compact, unique package that conveniently connects directly to Watts Radiant Stainless Steel manifolds.
      a. The IsoTherm module includes the following items:
         1) Mix Valve
         2) 3 speed 1/25 hp Circulator
         3) Temperature Guage
         4) Maximum Temperature Sensor
         5) Trunk Isolation Valves
         6) BSP to NPT Transition Nipple
      b. Mounting:
         1) The IsoTherm can be wall mounted with standard cush clamps or other copper pipe mounted brackets.
         2) The IsoTherm can be integrated into a standard Watts Radiant manifold box.
      c. Capacity:
         1) Full heat capacity of 51,000 BTU/h with a minimum boiler temperature of 158°F (70°C).
   2. Pressure Differential By-pass Valve (for use with 1” Stainless Steel Manifolds only):
      a. Use Watts Radiant Pressure Differential By-pass Valve with the manifolds incorporating actuators to avoid noise due to excessive water velocity.
         1) Eliminates water velocity noise and water hammer.
         2) Increases pump life because of minimal pressure surging as actuators open and close.
         3) There is always correct and constant flow regardless of the number of actuators or zone valves open.
         4) Water flow through the DBP valve shall be 25-30 % of the total flow:
            (a) The over-pressure shall not exceed 10-15 % of the system pressure drop.

(b) If the zones to be by-passed have a maximum pressure drop of 0.5 psi (3.5 kPa), the DBP valve shall be set to accommodate this pressure plus 10-15 %.
(c) The DBP valve needs to be installed 'downstream' of the main circulator.
(d) Install before the system zones
(e) Should connect the supply line with the return line

3. FlowGuard:
   a. FlowGuards shall be of commercial-quality, non-electronic flow indicator and flow setter.
   b. Cast brass construction
   c. Accurate visual flow indication in GPM
   d. Ability to set fluid flow
   e. FlowGuards shall allow zone-by-zone control and optimization.
   f. No special training or electronic instrumentation required,
   g. Sizes:
      1) 1" (25 mm) MNPT ends: 0.5 – 4 gpm (0.03 to 0.25 L/sec) flow meter
      2) 1" (25 mm) FNPT ends: 1 – 13 gpm (0.06 to 0.8 L/sec) flow meter
4. Tempering Valves:
   a. MixTemp 180 Mixing Valve:
      1) The MixTemp 180 is a 3 port, non-electric nix valve for use in Hydronic heating systems.
         (a) Hot, cold, and mix ports are clearly marked "H," "C," and "M."
      2) This mix valve shall be capable of delivering water temperatures ranging from 90° to 160°F (32° to 71°C) +/- 3° F.
      3) The Hydronic mix valve shall have a cast bronze body.
      4) Copper, stainless steel and EPDM internal parts
      5) There are no ferrous components to corrode.
      6) The actuator for the piston shall have lineal expansion characteristics, and shall be completely filled with a temperature-sensitive wax.
      7) Each port on the MixTemp has a union to allow for easy servicing
      8) Available in ¾" (19 mm) and 1" (25 mm) female NPT fittings.
         (a) ¾" Cv = 3.1 gpm (0.195 L/sec)
         (b) 1" Cv = 3.2 gpm (0.20 L/sec)
      9) These mixing valves are not anti-scald valves since they do not have positive shut-off in case of failure of hot or cold water supply. We do not recommend their use for shower service.
      10) Shall have a source of return water cooler than the desired mix temperature to operate properly.
      11) The mix valve shall not be heated in excess of 200°F (93°C) to prevent the liquid-filled actuator from rupture.
         (a) To prevent damage, temporarily remove the mixing valve from the unions before soldering near the mix valve.
   b. AllTemp Mixing Valve:
      1) The AllTemp shall be a non-electric, 3 port mix valve for use in hydronic heating systems.
      2) Valve shall be capable of delivering water temperatures ranging from 100 – 200°F (38 – 93°C).
      3) The hydronic mix valve shall have a cast bronze body.
      4) Chrome-plated bronze piston

5) The actuator for the piston shall have linear expansion characteristics, and shall be completely filled with a temperature-sensitive liquid communicating with the hydraulically formed NPT fittings.
6) The AllTemp is available in 1¼" (32 mm), 1½" (38 mm), and 2" (51 mm) female NPT fittings.
   (a) 1¼" Cv = 6.1 gpm (0.38 L/sec)
   (b) 1½" Cv = 6.2 gpm (0.39 L/sec)
   (c) 2" Cv = 9.1 gpm (0.6 L/sec)
7) Mixing valves are not anti-scald valves since they do not have positive shut-off in case of failure of hot or cold water supply. Do not use for shower service.
8) Shall have a source of cooler return water to operate properly.
9) The mix valve shall not be heated in excess of 230°F (110°C), or the liquid-filled actuator may rupture.
   (a) To prevent damage, temporarily remove the actuator assembly from the valve body before soldering near the mix valve.

5. Staples: Watts Radiant Foamboard Staples
6. Terminal 90-degree Exit Bend: Terminal Bend Supports

PART 3 EXECUTION

3.1 EXAMINATION

A. Site Verification of Conditions:
   1. Verify that site conditions are acceptable for installation of the system. Refer to manufacturer's installation manual for information.
   2. Do not proceed with installation of the system until unacceptable conditions are corrected.

3.2 INSTALLATION OF FLOOR HEATING SYSTEMS

A. Comply with manufacturer's product data, including product technical bulletins, installation instructions and design drawings, including the following:
   1. Installation manuals
   2. Design software engineering and analysis

B. Slab-On-Grade Installation:
   1. Fasten the tubing to the flat mesh or reinforcing bar in accordance with the tubing manufacturer's installation recommendations.
   2. Use closer tubing on-center distances along exterior walls. Increase tubing on-center distances as the installation moves away from the exterior wall as determined by manufacturer analysis.
   3. Staple the tubing to the insulation board.

4. Install edge insulation where the heated panel directly contacts an exterior wall or panel.
5. Install tubing at a consistent depth below the surface elevation. Ensure sufficient clearance to avoid control joint saw cutting.
6. Where tubing crosses metal expansion joints in the concrete, ensure the tubing passes below the joints or is sleeved through the joint.

C. Pre-Cast Plank Construction with a Cap Pour:
   1. Fasten the tubing to the flat mesh or reinforcing bar, or snap into Triple-track or Single-track RailWays in accordance with the tubing manufacturer's installation recommendations.
   2. Use closer tubing on-center distances along exterior walls. Increase tubing on-center distances as the installation moves away from the exterior wall.
   3. Staple the tubing to the insulation board.
   4. Install edge insulation where the heated panel directly contacts an exterior wall or panel.
   5. Install tubing at a consistent depth below the surface elevation. Ensure sufficient clearance to avoid control joint saw cutting.
   6. Where tubing crosses metal expansion joints in the concrete, ensure the tubing passes below the joints or is sleeved through the joint.

D. Wood Floor Construction with a Lightweight Gypsum Topping:
   1. Staple tubing to the wood sub-floor in accordance with the tubing manufacturer's installation recommendations. The attachment method shall not cause abrasions on the tubing.
   2. Use closer tubing on-center distances along exterior walls. Increase tubing on-center distances as the installation moves away from the exterior wall.
   3. Ensure the depth of the lightweight pour is a minimum of ¾" (19 mm) over the outside dimension of the tubing, 1" typical overall thin-slab thickness.
   4. Install reinforcing mesh within the pour for finished flooring of tile or linoleum.
   5. Install wood sleepers along the room perimeter and between the tubing to provide a nailing surface for finished wood floors or carpet tack strips as required. Refer to Section 06100.
   6. Allow lightweight gypsum concrete pour to cure in accordance with the applicator's instructions. Once cured, seal the surface of the floor topping to protect surface from moisture.
   7. Install insulation in the joist cavity below the floor in accordance with the submitted radiant floor design. Refer to Section 07210.
   8. Install edge insulation if the heated panel directly contacts an exterior wall or panel. Refer to Section 07210.

E. Wood Floor Construction with UnderFloor Heating (Onix tubing attached directly to wood sub-floor):
   1. Install tubing attached directly to the underside of the wood sub-floor in accordance with the tubing manufacturer's recommendations. The attachment method shall not puncture or cause abrasions to the tubing.
   2. Do not exceed 8" (203 mm) on center tube spacing. Refer to the submitted radiant floor design.

3. Comply with the tubing manufacturer's installation procedures on proper joist drilling.
4. Install foil-faced insulation in the lower portion of the joist cavity. Allow an air gap of 2 – 3" (51 – 76 mm) between the wood sub-floor and the top of the insulation. Refer to Section 07210.
5. Use the recommended amount of insulation in the joist cavity below the floor in accordance with the submitted radiant floor design. Refer to Section 07210.
6. Use edge insulation equal to the amount of underfloor insulation if the heated panel directly contacts an exterior wall or panel. Refer to Section 07210.

F. Wood Floor Construction with Joist Heating (tubing suspended in the joist bay):
1. Install tubing within the joist cavity in accordance with the tubing manufacturer's recommendations. The attachment method shall not cause abrasions to the tubing.
2. Do not exceed 8" (203 mm) on center. Refer to the submitted radiant floor design.
3. Do not allow tubing within the joist cavity to contact the wood sub-floor.
4. Refer to the tubing manufacturer's installation procedures on proper joist drilling.
5. Install foil-faced insulation in the lower portion of the joist cavity. Allow an air gap of 2 – 3" (51 – 76 mm) between the wood sub-floor and the top of the insulation. Refer to Section 07210.
6. Use the recommended amount of insulation in the joist cavity below the floor in accordance with the submitted radiant floor design. Refer to Section 07210.
7. Use edge insulation equal to the amount of underfloor insulation if the heated panel directly contacts an exterior wall or panel. Refer to Section 07210.

G. Wood Floor Construction with SubRay:
1. Install SubRay on top of the wood sub-floor according to the tubing manufacturer's instructions.
2. Coordinate the finished floor covering layout direction with the direction of the SubRay layout. Comply with the tubing manufacturer's instructions.
3. Install insulation in the joist cavity below the floor according to the submitted radiant floor design. Install the insulation tight against the wood sub-floor. Refer to Section 07210.
4. Use the recommended amount of insulation in the joist cavity below the floor in accordance with the submitted radiant floor design. Refer to Section 07210.
5. Use edge insulation equal to the amount of underfloor insulation if the heated panel directly contacts an exterior wall or panel. Refer to Section 07210.

H. Glycol and Water Solution:
1. Provide premixed glycol and water solutions.
2. Do not use ethylene glycol due to toxicity issues. Provide inhibited propylene glycol for hydronic radiant floor heating systems. Refer to the boiler manufacturer's recommendations.

3.3 INSTALLATION OF HYDRONIC SNOW MELTING SYSTEM

A. Slab-On-Grade Installation:
   1. Fasten the tubing to the rewire or rebar in accordance with the tubing manufacturer's installation recommendations.
   2. Install tubing at a consistent depth below the surface elevation. Ensure sufficient clearance to avoid control joint saw cutting.
   3. Install an extruded polystyrene insulation board at the edge of, and optionally under, the slab, depending on site conditions.
   4. Where tubing crosses metal expansion joints in the concrete, ensure that the tubing passes below the joints or is sleeved through the joints in accordance with manufacturer's instructions.

B. Slab over Steel Deck Installation:
   1. Fasten tubing to either rewire or rebar, or snap tubing into Triple or Single-track RailWays in accordance with manufacturer's installation instructions.
   2. If rewire or rebar is not used, install the tubing perpendicular to the ribbing on the steel deck.
   3. Install either spray-on insulation or insulation board under the steel deck as per the manufacturer's directions.

C. Brick Pavers over Concrete Slab Installation:
   1. Fasten the tubing to the rewire or rebar in accordance with the tubing manufacturer's installation recommendations.
   2. Install tubing at a consistent depth below the surface elevation.
   3. Install the brick pavers on top of the concrete according to proper masonry practice and guidelines for this application.

D. Brick Pavers over Sand or Stone Dust Installation:
   1. Fasten the tubing to the rewire or rebar in accordance with the tubing manufacturer's recommendations for installation in base material.
   2. Install tubing at a consistent depth below the surface elevation.
   3. Place a layer of sand over the tubing to a depth that results in the manufacturer's recommended minimum depth when compacted.
   4. Install the brick pavers on the compacted material according to proper masonry practice and guidelines for this application.

E. Asphalt Installation:
   1. Fasten the tubing to the rewire or rebar in accordance with the tubing manufacturer's recommendations for installation in sub-base material.
   2. Install tubing at a consistent depth below the surface elevation.
   3. Ensure that there is a minimum of 2" (51 mm) of material covering the installed tubing.

3.4 FIELD QUALITY CONTROL AND TESTING

A. Site tests:

1. To ensure system integrity, pressure test the system before covering tubing in concrete or when other trades are working in the vicinity of the tubing.
2. Test all electrical controls in accordance with respective installation manuals.
3. System shall be checked after 3 years of operation and every year thereafter. System shall be checked for pH levels to ensure that it is operating within suggested guidelines.

3.5 SYSTEM ADJUSTING

A. Balancing Across Manifold: Balance all loops across each manifold for equal flow resistance based on actual loop lengths and total manifold flow.

B. Balancing between manifolds is accomplished with a flow control device installed on the return piping leg from each manifold when direct return piping is used for the supply and return mains or the circuits deviate by more than 10%.

3.6 CLEANING

A. Remove temporary coverings and protection of adjacent work areas.

B. Repair or replace damaged installed products.

C. Clean installed products in accordance with manufacturer's instructions prior to Owner's acceptance.

D. Remove construction debris from project site and legally dispose of debris.

3.7 DEMONSTRATION

A. Demonstrate operation of system to Owner or Owner's personnel.

B. Instruct the Owner or Owner's personnel about the type, concentration and maintenance of the glycol and water solution.

C. Provide Owner or Owner's personnel with manufacturer's installation, operation, and maintenance instructions for installed components within the system.

3.8 PROTECTION

A. Protect installed work from damage caused by subsequent construction activity on the site. Provide Owner with copy of photos and drawings of product locations to assist.

SECTION 237339 - DIRECT FIRED MAKEUP UNITS

GENERAL

SUMMARY

This Section includes direct-fired, makeup air units and accessories.

Related Sections include the following:

SUBMITTALS

Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each unit.

Shop Drawings:

Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases. Reference Section 15240

Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

Maintenance Data: For direct-fired, makeup air units to include in maintenance manuals specified in Division 1.

QUALITY ASSURANCE

Product Options: Drawings indicate size, profiles, and dimensional requirements of direct-fired, makeup air units and are based on the specific system indicated. Other manufacturers' systems with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."

AGA Certification: Gas-fired units shall be certified and labeled.

EXTRA MATERIALS

Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

Filters: One set for each unit.

Fan Belts: One set for each unit.

PRODUCTS

MANUFACTURERS

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Engineered Air

Greenheck

Hastings Industries; Division of Eric, Inc.

Jackson & Church; Div. of Donlee Technologies Inc.

Trane

Rapid Engineering, Inc.

Reznor/Thomas & Betts

PACKAGED UNITS

Factory-assembled, prewired, self-contained unit consisting of casing, supply fan, controls, filters, and gas burner with profile plate.

General Construction: Outdoor unit.

General Construction: Indoor unit.

Refrigeration Component Construction and Ratings: Comply with ARI 210/240, ASHRAE 37, UL 207, and UL 303.

CASING AND COMPONENTS

Casing: Minimum 0.052-inch-thick, galvanized-steel panels, formed to ensure rigidity and fastened with sheet metal screws or pop rivets; supported by galvanized-steel channels or structural channel supports; with access panels for burner and fan motor assemblies from both sides of unit; and with lifting lugs.

Access Panels: Lift-out with cam-lock fasteners.

Access Panels: Piano hinged with cam-lock fasteners.

Access Panels: Piano hinged with vent-lock handles operable from both sides.

Insulation: Factory-applied, neoprene-faced, glass-fiber insulation, 1 inch-thick, applied on complete unit.

Finish: Heat-resistant, baked enamel.

Weatherproofing: Factory applied to casing.

Filters: Removable 1-inch-thick, high-velocity, permanent filters in metal frames.

Filters: Removable 1-inch-thick, glass-fiber, disposable filters in metal frames.

Filters: Removable 2-inch-thick, glass-fiber, disposable filters in metal frames.

Service Platform: Factory fabricated, minimum 42 inches (1060 mm) wide, of expanded metal with angle iron siderails and kick plates, handrails, and access ladder.

Discharge Head: Galvanized-steel assembly with diffusers incorporating individually adjustable vanes.

Four-way pattern

Four-way pattern with filters

Horizontal pattern

Roof Curb: Full-perimeter curb of sheet metal, minimum 12 inches (300 mm) high, with wood nailer, neoprene sealing strip, and welded Z-bar flashing.

FUEL BURNING SYSTEM

Burners: Capable of modulating turndown ratio of 25:1, including electric-modulating main gas valve, motorized shutdown valve, main and pilot gas regulators, pilot electric gas valve, manual shutoff valve, and pilot adjustment valve.

Fuel: Natural gas

Fuel: Propane gas

Fuel: Butane gas

Pilot: Electrically ignited by spark rod through high-voltage-ignition transformer

Safety Controls: Factory-installed sensors verify correct airflow before energizing pilot and sense pilot ignition before activating main gas valve

Manual-Reset, Low- and High-Limit Controls: Maintain supply-air temperature between set points, and shut fan down if temperatures are exceeded

Purge-Period Timer: Automatically delays burner ignition and bypasses low-limit control

Select inlet damper below; not required for all applications

Inlet Damper: Motorized, with end switch to prove position before burner will fire

Two-position damper to open when unit is operating

Three-position damper to open to fully open or to preset throttling position when unit is operating

FAN

Description: Rated according to AMCA 210; statically and dynamically balanced, galvanized-steel, centrifugal fan mounted on solid-steel shaft with heavy-duty, self-aligning, prelubricated ball bearings and V-belt drive with matching motor sheaves and belts.

Fan Type: Forward curved

Fan Type: Backward inclined

CONTROLS

Factory-wire connection for power supply and field-wire unit to remote control panel.

Remote control panel shall have the following features:

On-off switch

On-off-auto switch

Summer-winter switch

Heat-off-cool switch

Supply-fan indicating light

Exhaust-fan indicating light

Pilot-operation indicating light

Burner-operation indicating light

Clogged-filter indicating light

Safety-lockout indicating light

Interlocks: Start unit when exhaust fan is running. Operate burner when flow switch located in exhaust duct proves airflow.

Exhaust-fan speed control operates with inlet damper and burner profile damper to provide dual-volume air capacity.

Exhaust fans operate with inlet damper and burner profile damper to provide dual-volume operation.

Fan Discharge Thermostat: Controls modulating gas valve to maintain supply-air temperature.

Remote Discharge Thermostat: Adjustment within 20 feet (6 m) of unit.

Remote Discharge Thermostat: Adjustment in excess of 20 feet (6 m) of unit.

Room Thermostat: To reset discharge thermostat a minimum of three temperature levels.

Timer: Electronic clock timer turns fan system off at night.

Timer: Electronic clock timer operates fan system on low volume at night.

Remote Override Thermostat: Adjustable room thermostat selected by timer, set at 50 deg F, energizes system on low temperature.

EXECUTION

INSTALLATION

Install units according to manufacturer's written instructions.

Install gas-fired units according to AGA Z223.1.

Install suspended units from spring hangers with minimum 1-inch (25-mm) static deflection; refer to Division 15 Section "Mechanical Vibration Controls and Seismic Restraints."

Install floor- or roof-mounted units on spring isolators with minimum 1-inch (25-mm) static deflection; refer to Division 15 Section "Mechanical Vibration Controls and Seismic Restraints."

Install roof-mounted units on curbs complying with requirements in Division 7 Section "Roof Accessories."

Mount condensing units on roof on curbs complying with requirements in Division 7 Section "Roof Accessories."

CONNECTIONS

Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

Install piping adjacent to machine to allow service and maintenance.

Gas Piping: Comply with applicable requirements in Division 15 Section "Natural Gas Piping." Connect gas piping with shutoff valve and union and with sufficient clearance for burner removal and service. Provide AGA-approved flexible connectors.

Makeup Water Connection: Comply with applicable requirements in Division 15 Section "Water Distribution Piping" for valves and accessories on piping connections to water-cooled units.

Refrigerant Piping Connections: Comply with applicable requirements in Division 15 Section "Refrigerant Piping" for valves and accessories on piping connections to units.

Duct Connections: Comply with applicable requirements in Division 15 Section "Duct Accessories" for flexible connectors.

Ground Equipment

Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

COMMISSIONING

Engage a factory-authorized service representative to perform startup service.

Verify that equipment is installed and connected according to manufacturer's written instructions.

Complete installation and startup checks according to manufacturer's written instructions.

Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.

Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

DEMONSTRATION

Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain direct-fired, makeup air units.

Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.

Review data in maintenance manuals. Refer to Division 1 Section "Contract Closeout."

Review data in maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."

Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION

SECTION 23 81 29 – VARIABLE REFRIGERANT FLOW HVAC SYSTEMS

GENERAL

WORK INCLUDES

- Complete system of automatic controls
- Installation and interface with building automation system
- Control devices, components, wiring, and materials
- Assist in system validation of control systems, including device calibration, software validation and system wiring
- Instructions to Owner

SUMMARY

A. Section Includes: VRF HVAC systems.

Indoor, concealed, floor-mounted units for ducting.

Outdoor, air-source heat-pump units.

System controls.

System refrigerant and oil.

System condensate drain piping.

System refrigerant piping.

Metal hangers and supports.

Pipe stands.

Outdoor equipment stands.

Piping and tubing insulation.

DEFINITIONS

Air-Conditioning System Operation: System capable of operation with all zones in cooling only.

Heat-Pump System Operation: System capable of operation with all zones in either heating or cooling, but not with simultaneous heating and cooling zones that transfer heat between zones.

Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.

Three-Pipe System Design: One high pressure refrigerant vapor line, one low pressure refrigerant vapor line, and one refrigerant liquid line connect a single outdoor unit or multiple manifold outdoor units in a single system to associated system HRCUs. One liquid line and refrigerant vapor line connect HRCUs to associated indoor units.

Two-Pipe System Design: One refrigerant vapor line and one refrigerant liquid line connect a single outdoor unit or multiple manifold outdoor units in a single system to associated system HRCUs. One refrigerant liquid line and refrigerant vapor line connect HRCUs to associated indoor units. HRCUs used in two pipe systems act as an intermediate heat exchanger and include diverting valves and gas/liquid separators to move high and low pressure refrigerant between indoor units.

VRF: Variable refrigerant flow.

ACTION SUBMITTALS

Product Data: For VRF HVAC system components.

Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for indoor and outdoor units.

Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

Include operating performance at design conditions and at extreme maximum and minimum outdoor ambient conditions.

Include description of system controllers, dimensions, features, control interfaces and connections, power requirements, and connections.Include system operating sequence of operation in narrative form for each unique indoor- and outdoor-unit control.

Include description of control software features.

Include total refrigerant required and a comprehensive breakdown of refrigerant required by each system installed.

Include refrigerant type and data sheets showing compliance with requirements indicated.

Indicate location and type of service access.

INFORMATIONAL SUBMITTALS

Qualification Data:

For Installer: Certificate from VRF HVAC system manufacturer certifying that Installer has successfully completed prerequisite training administered by manufacturer for proper installation of systems, including but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.

Retain copies of Installer certificates on-site and make available on request.

For VRF HVAC system manufacturer.

For VRF HVAC system provider.

DELIVERY, STORAGE, AND HANDLING

Deliver and store products in a clean and dry place.

Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.

Protect products from weather, dirt, dust, water, construction debris, and physical damage.

Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.

Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remover coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.

Replace installed products damaged during construction.

PART PRODUCTS

VRF HVAC SYSTEMS

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Daikin Applied.

LG Electronics USA, Inc.; LG Electronics Inc.

Mitsubishi Electric & Electronics USA, Inc.

Trane Inc.

Source Limitations: Obtain products from single source from single manufacturer including, but not limited to, the following:

Indoor and outdoor units, including accessories.

Controls and software.

HRCUs.

Refrigerant isolation valves.

Specialty refrigerant pipe fittings.

SYSTEM DESCRIPTION

Direct-expansion (DX) VRF HVAC system(s) with variable capacity in response to varying cooling and heating loads. System shall consist of multiple indoor units, HRCUs, outdoor unit(s), piping, controls, and electrical power to make complete operating system(s) complying with requirements indicated.

Two-pipe or three-pipe system design.

System(s) operation, heat pump as indicated on Drawings.

Each system with one refrigerant circuit shared by all indoor units connected to system.

Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

AHRI Compliance: System and equipment performance certified according to AHRI 1230 and products listed in AHRI directory.

ASHRAE Compliance:

ASHRAE 15: For safety code for mechanical refrigeration.

ASHRAE 62.1: For indoor air quality.

ASHRAE 135: For control network protocol with remote communication.

ASHRAE/IES 90.1 Compliance: For system and component energy efficiency.

UL Compliance: Comply with UL 1995.

The variable capacity, heat recovery air conditioning system shall be a Variable Refrigerant Volume Series (heat and cool model) split system as specified. The system shall consist of multiple evaporators, branch selector boxes, joints and headers, a three pipe refrigeration distribution system using PID control, and Daikin VRV□□outdoor unit. The outdoor unit is a direct expansion (DX), air-cooled heat recovery, multi-zone air- conditioning system with variable speed driven compressors using R-410A refrigerant. The outdoor unit may connect an indoor evaporator capacity up to 200% of the outdoor condensing unit capacity. All zones are each capable of operating separately with individual temperature control.

Operation of the system shall permit either individual cooling or heating of each fan coil simultaneously or all of the fan coil units associated with one branch cool/heat selector box (BSQ). Each fan coil or group of fan coils shall be able to provide set temperature independently via a local remote controller, an Intelligent Controller, an Intelligent Manager or a BMS interface.

Branch selector boxes shall be located as shown on the drawing. The branch selector boxes shall have the capacity to control up to 290 MBH (cooling) downstream of the branch selector box. Each branch of the branch selector box shall consist of three electronic expansion valves, refrigerant control piping and electronics to facilitate communications between the box and main processor and between the box and indoor units. The branch selector box shall control the operational mode of the subordinate indoor units. The use of three EEV’s ensures continuous heating during defrost (multiple condenser systems), no heating impact during changeover and reduced sound levels.

If proposed alternate manufacturer has solenoid valves in their branch selector box, the alternate manufacturer shall provide a secondary, removable sheet metal fabricated enclosure to completely encapsulate the VRV branch selector box. This secondary enclosure shall be filled with fiberglass or foam for sound mitigation purposes.

Check manufacturer’s requirements for the number of units that can be connected together. Each individual condensing unit module is specified to have dual compressors so the module can continue to run on one compressor in emergency mode if the other compressor fails. For manufacturers proposing any individual module with a single compressor, a backup (spare compressor) must be provided to the owner to stock for every condensing unit module on the project that has a single compressor. In the event of compressor failure the remaining compressors shall continue to operate and provide heating or cooling as required at a proportionally reduced capacity. Each indoor unit or group of indoor units shall be independently controlled.

REQUIRED FEATURES

Voltage Platform – Heat pump and heat recovery condensing units shall be available with a 208-230V/3/1/60 power supply.

Advanced Zoning – A single system shall provide for up to 64 zones.

Auto charging – Each condensing unit is specified to be provided with an automatic charging feature that does not require manual calculation ofrefrigerant line lengths. If the proposed manufacturer does not have an automatic charge feature, spare R-410A refrigerant totaling the entire amount provided in the VRV system shall be provided to the owner to stock at the facility.

Charge Checking – Each system shall have a refrigerant charge checking function.

Heat During Defrost and Heat during Oil Recovery – For proposed alternate manufacturer that does not heat during all cycles of defrost and oil recovery, supplemental electric heat must be provided at each fan coil. The proposed alternate manufacturer shall not only provide the supplemental electric heat in each zone, but also shall include all cost from power electrician to power these heaters and interlock the heaters into the VRV system.

Independent Control – Each fan coil shall use a dedicated electronic expansion valve for independent control.

VFD Inverter Control – Each condensing unit shall use a high efficiency, variable speed "inverter" compressor coupled with inverter fan motors for superior part load performance. All variable frequency drives located in the outdoor condensing unit shall be refrigerant cooled by the outdoor condensing unit refrigerant circuit to allow for stable operation and maximum life. Alternate manufacturers that use ambient air to cool the variable frequency drives shall provide a spare variable frequency drive for each condensing unit on the project.

Compressor capacity shall be modulated automatically to maintain a constant suction pressure, while varying the refrigerant volume for the needs of the cooling or heating loads.

Indoor fan coil units shall use PID control to control superheat to deliver a comfortable room temperature condition.

Configurator software – Each system shall be available with configurator software package to allow for remote configuration of operational settings and also for assessment of operational data and error codes. If this software is not provided by an alternate manufacturer, for each individual outdoor unit the contractor shall do the settings manually and keep detailed records for future maintenance purposes.

Flexible Design

Systems shall be capable of up to 540ft (640ft equivalent) of linear piping between the condensing unit and furthest located fan coil unit.

Systems shall be capable of up to 3,280ft total "one-way" piping in the piping network.

Systems shall have a vertical (height) separation of up to 295ft between the condensing unit and the fan coil units.

Systems shall be capable of 295ft from the first branch point.

The outdoor unit shall connect an indoor evaporator capacity up to 200% of the outdoor condensing unit capacity.

Systems shall be capable of 98ft between fan coil units.

Condensing units shall be supported with a fan/fan motor ESP up to 0.32” WG as standard to allow connection of discharge ductwork and to prevent discharge air short circuiting.

Simple Wiring – Systems shall use 16 AWG, 2 wire, multi-stranded, non- shielded and non-polarized daisy chain control wiring.

Energy Efficiency – System shall have equivalent or better performance than high efficiency air cooled or water cooled chiller systems.

Outside Air – Systems shall provide outside air capability.

Space Saving – Each system shall have a condensing unit module footprint as small as 3’ 5/8” x 2’ 6-1/8” (7.66sq ft).

Advanced Diagnostics – Systems shall include a self-diagnostic, auto-check function to detect a malfunction and display the type and location.

Advanced Controls – Each system shall have at least one remote controller capable of controlling up to 16 fan coil units.

Compressors in the outdoor units must be provided with a dome temperature sensor. Alternate manufacturers that do not have on-board compressor temperature sensors must provide a third party temperature sensor. This sensor must report to the on-board control system to stop operation based on elevated temperatures to not only protect the compressor from failure and increase compressor life.

Low Sound Levels – Each system shall use indoor and outdoor units with quiet operation as low as 27 dB(A).

PERFORMANCE REQUIREMENTS

Service Access:

Provide and document service access requirements.

Locate equipment, system isolation valves, and other system components that require service and inspection in easily accessible locations. Avoid locations that are difficult to access if possible.

Where serviceable components are installed behind walls and above inaccessible ceilings, provide finished assembly with access doors or panels to gain access. Properly size the openings to allow for service, removal, and replacement.

If less than full and unrestricted access is provided, locate components within an 18-inch reach of the finished assembly.

Where ladder access is required to service elevated components, provide an installation that provides for sufficient access within ladder manufacturer's written instructions for use.

Comply with OSHA regulations.

System Design and Installation Requirements:

Design and install systems indicated according to manufacturer's recommendations and written instructions.

Where manufacturer's requirements differ from requirements indicated, contact Architect for direction. The most stringent requirements should apply unless otherwise directed in writing by Architect.

Isolation of Equipment: Provide isolation valves to isolate each indoor unit and outdoor unit for service, removal, and replacement without interrupting system operation.

System Capacity Ratio: The sum of connected capacity of all indoor units shall be within the following range of outdoor-unit rated capacity:As scheduled on drawings.

System Turndown: Stable operation down to 20 percent of outdoor-unit capacity.

floor blower coil unit

Concealed Unit Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.

Insulation: Faced, glass-fiber duct liner.

Drain Pans: Galvanized steel, with connection for drain; insulated.

Floor-Mounting, Unit Cabinet: Enameled steel with removable panels on front and ends.

Discharge Grille: Steel with surface-mounted frame.

Insulation: Faced, glass-fiber, duct liner.

Drain Pans: Galvanized steel, with connection for drain; insulated.

Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

Evaporator Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.

Fan Motor: Multispeed.

Filters: 1 inch thick, in fiberboard frames.

4 WAY CEILING CASSETTE UNIT (3'x3')

A. General: The ceiling cassette fan coil unit, operable with R-410A refrigerant, equipped with an electronic expansion valve, for installation into the ceiling cavity equipped with an air panel grill. It shall be available from 7,500 Btu/h to 48,000 Btu/h. It shall be a 360 degree air distribution type, ivory white, impact resistant, and washable decoration panel. The supply air is distributed via motorized louvers which can be horizontally and vertically adjusted from 0° to 90°. Computerized PID control shall be used to maintain room temperature within 1°F. Equipped with a

programmed drying mechanism that dehumidifies while inhibiting changes in room temperature when used with remote control. The indoor units sound pressure shall range from 28 dB(A) to 33 dB(A) at low speed measured at 5 feet below the unit.

B. Indoor Unit:
   1. The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
   2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
   3. Both refrigerant lines shall be insulated from the outdoor unit.
   4. Return air shall be through the concentric panel, which includes a resin net mold resistant filter.
   5. The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 33-1/2” of lift.
   6. The indoor units shall be equipped with a return air thermistor.
   7. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
   8. The voltage range will be 253 volts maximum and 187 volts minimum.
   9. Each ceiling cassette fan coil is specified as single zone VAV with proximity sensors and occupancy sensors. If the proposed manufacture cannot do all three of these items, they must (at a minimum) provide a wall mounted occupancy sensor for each fan coil unit that will put the unit in unoccupied mode when the space is empty. Occupied / Unoccupied space must be reported back through the centralized / Web Based front end control system.
   10. Each ceiling cassette fan coil is specified to have a self-cleaning filter. If the proposed manufacturer does not have a self-cleaning filter, (10) sets of spare washable filters must be provided. Additionally, a differential pressure filter switch shall be hard wired in the proposed alternate fan coil to alarm the centralized / web-based front end control system of a dirty filter.
   11. If proposed alternate manufacturer does not meet the specified fan coil airflow on high speed fan, the proposed manufacturer must go to the next fan coil unit size larger or provide two fan coils in the space to meet the specified high speed fan mode that ensures proper designed air circulation.

C. Unit Cabinet:
   1. The cabinet shall be space saving and shall be located into the ceiling.
   2. Three auto-swing positions shall be available to choose, which include standard, draft prevention and ceiling stain prevention.
   3. The airflow of the unit shall have the ability to shut down one or two sides allowing for simpler corner installation.
   4. Fresh air intake shall be possible by way of fresh air intake kit.

5. A branch duct knockout shall exist for branch ducting supply air.
6. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.
7. Optional high efficiency air filters are available for each model unit.

D. Fan:
1. The fan shall be direct-drive turbo fan type with statically and dynamically balanced impeller with high and low fan speeds available.
2. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range from 0.06 to 0.12 HP.
3. The airflow rate shall be available in high and low settings.
4. The fan motor shall be thermally protected.

E. Filter:
1. The ceiling cassette decoration panel shall be provided with a self-cleaning filter panel, which performs automatic filter cleaning up to once a day, with dust collection box that indicates when to be emptied

F. Coil:
1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall be a 2-row cross fin copper evaporator coil with 17 FPI design completely factory tested.
4. The refrigerant connections shall be flare connections and the condensate will be 1 -1/4 inch outside diameter PVC.
5. A condensate pan shall be located under the coil.
6. A condensate pump with a 33-1/2 inch lift shall be located below the coil in the condensate pan with a built in safety alarm.
7. A thermistor will be located on the liquid and gas line.

G. Electrical:
1. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
3. Transmission (control) wiring between the indoor and remote controller shall be a maximum distance of 1,640 feet.

H. Control:
1. The unit shall have manufacturer provided controls to perform input functions necessary to operate the system.

4 WAY CEILING CASSETTE UNIT (2'x2')

A. General: The indoor unit shall be a ceiling cassette fan coil unit, operable with R-410A refrigerant, equipped with an electronic expansion valve, for installation into the ceiling cavity equipped with an air panel grill. It shall be available from 7,500 Btu/h to 18,000 Btu/h. Units to be connected to an outdoor heat pump heat recovery model. It shall be a four-way air distribution type, ivory white, impact resistant, and washable decoration panel. The supply air is distributed via motorized louvers which can be horizontally and vertically adjusted from 0° to 90°. Computerized PID control shall be used to maintain room temperature within 1°F. Equipped with a programmed drying mechanism that dehumidifies while inhibiting changes in room temperature when used with remote control. The indoor units sound pressure shall range from 25 dB(A) to 33 dB(A) at low speed measured at 5 feet below the unit.

B. Performance: Each unit's performance is based on nominal operating conditions.

C. Indoor Unit:

1. The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, self- diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.

2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
3. Both refrigerant lines shall be insulated from the outdoor unit.
4. The 4-way supply air flow can be field modified to 3-way and 2-way airflow to accommodate various installation configurations including corner installations.
5. Return air shall be through the concentric panel, which includes a resin net mold resistant filter.
6. The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 21" of lift.
7. The indoor units shall be equipped with a return air thermistor.
8. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
9. The voltage range will be 253 volts maximum and 187 volts minimum.

D. Unit Cabinet:

1. The cabinet shall be space saving and shall be located into the ceiling.
2. Three auto-swing positions shall be available to choose, which include standard, draft prevention and ceiling stain prevention.
3. The airflow of the unit shall have the ability to shut down one or two sides allowing for simpler corner installation.
4. Fresh air intake shall be possible by way of Daikin's optional fresh intake
5. A branch duct knockout shall exist for branch ducting supply air.
6. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

E. Fan:

1. The fan shall be direct-drive turbo fan type with statically and dynamically balanced impeller with high and low fan speeds available.
2. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a output range from 0.06 to 0.12 HP.
3. The airflow rate shall be available in high and low settings.
4. The fan motor shall be thermally protected.

F. Filter:

1. The return air shall be filtered by means of a washable long-life filter with mildew proof resin.

G. Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore design to ensure highly efficient performance.
3. The coil shall be a 2-row cross fin copper evaporator coil with 17 FPI completely factory tested.
4. The refrigerant connections shall be flare connections and the condensate be 1 -1/4 inch outside diameter PVC.
5. A condensate pan shall be located under the coil.
6. A condensate pump with a 21 inch lift shall be located below the coil in the condensate pan with a built in safety alarm.
7. A thermistor will be located on the liquid and gas line.

H. Electrical:

1. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).

3. Transmission (control) wiring between the indoor and remote controller shall be a maximum distance of 1,640 feet.

I. Control:

1. The unit shall have controls provided by Daikin to perform input functions necessary to operate the system.

OUTDOOR UNIT

A. General: The outdoor unit is designed specifically for use with VRV IV series components.

1. The outdoor unit shall be factory assembled in the USA and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of Daikin scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant regulator. All outdoor units must have a minimum of 2 compressors. Single compressor outdoor units will not be allowed as two compressors are required redundancy / backup. In the event of compressor failure the remaining compressors shall continue to operate and provide heating or cooling as required at a proportionally reduced capacity.
   High/low pressure gas line, liquid and suction lines must be individually insulated between the outdoor and indoor units.
2. The outdoor unit can be wired and piped with outdoor unit access from the left, right, rear or bottom.
3. The connection ratio of indoor units to outdoor unit shall be permitted up to 200%.
4. Each outdoor system shall be able to support the connection of up to 64 indoor units dependent on the model of the outdoor unit.
5. The sound pressure level standard shall be that value as listed in the Daikin engineering manual for the specified models at 3 feet from the front of the unit. The outdoor unit shall be capable of operating automatically at further reduced noise during night time.
6. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for reprogramming.
7. The unit shall incorporate an auto-charging feature and a refrigerant charge check function.
8. The outdoor unit shall be modular in design and should allow for side-by-side installation with minimum spacing.

9. The following safety devices shall be included on the condensing unit; high pressure switch, control circuit fuses, crankcase heaters, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
10. To ensure the liquid refrigerant does not flash when supplying to the various fan coil units, the circuit shall be provided with a sub-cooling feature.
11. Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation.
12. The outdoor unit shall be capable of heating operation at down to -40°F dry bulb ambient temperature without additional low ambient controls.
13. The system shall continue to provide heat to the indoor units in heating operation while in the defrost mode.

B. Unit Cabinet:
1. The outdoor unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.

C. Fan:
1. The condensing unit shall consist of two or more propeller type, direct-drive 350 and 750 W fan motors that have multiple speed operation via a DC (digitally commutating)

inverter. All outdoor units must have a minimum of 2 fans. Single fan outdoor units will not be allowed as two fans are required redundancy / backup.

2. The condensing unit fan motor shall have multiple speed operation of the DC (digitally commutating) inverter type, and be of high external static pressure and shall be factory set as standard at 0.12 in. WG. A field setting switch to a maximum 0.32 in. WG pressure is available to accommodate field applied duct for indoor mounting of condensing units.
3. The fan shall be a vertical discharge configuration with a nominal airflow maximum range of 6,700 CFM to 14,120 CFM 5,544 CFM to 24,684 CFM dependent on model specified.
4. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.
5. The fan motor shall be provided with a fan guard to prevent contact with moving parts.
6. Night setback control of the fan motor for low noise operation by way of automatically limiting the maximum speed shall be a standard feature. Operation sound level shall be selectable from 3 steps as shown below.

Operation Sound (dB)	Night Mode Sound Pressure Level
Step 1 max.	55
Step 2 max.	50
Step 3 max.	45

D. Condenser Coil:
   1. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
   2. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.
   3. The heat exchanger on the condensing units shall be manufactured from seamless copper tube with N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design.
   4. The fins are to be covered with an anti-corrosion Ultra Gold coating as standard with a salt spray test rating of 1000hr (ASTM B117 & Blister Rating:10), Acetic acid salt spray test: 500hr (ASTM G85 & Blister Rating:10).
   5. The pipe plates shall be treated with powdered polyester resin for corrosion prevention. The thickness of the coating must be between 2.0 to 3.0 microns.
   6. The outdoor coil shall have three-circuit heat exchanger design eliminating the need for bottom plate heater. The lower part of the coil shall be used for inverter cooling and be on or off during heating operation enhancing the defrost operation.

E. Compressor:
   1. The inverter scroll compressors shall be variable speed (PAM inverter) controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity

(INV frequency or STD ON/OFF) shall be controlled to eliminate deviation from target value.

2. The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed scroll “G-type” with a maximum speed of 7,980 rpm.
3. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
4. The capacity control range shall be as low as 6% to 100%.
5. Units with non-inverter (standard) compressors shall not be allowed.
6. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.

7. Oil separators shall be standard with the equipment together with an intelligent oil management system.
8. The compressor shall be spring mounted to avoid the transmission of vibration.
9. Units sized 8-12 ton shall contain a minimum of 2 compressors, 14-16 ton units shall contain a minimum of 3 compressors and 18-20 ton shall contain a minimum of 4 compressors. In the event of compressor failure the remaining compressors shall continue to operate and provide heating or cooling as required at a proportionally reduced capacity. The microprocessor and associated controls shall be designed to specifically address this condition.
10. In the case of multiple condenser modules, conjoined operation hours of the compressors shall be balanced by means of the Duty Cycling Function, ensuring sequential starting of each module at each start/stop cycle, completion of oil return, completion of defrost or every 8 hours.

F. Electrical:
1. The power supply to the outdoor unit shall be 208-230 volts, 3 phase, 60 hertz +/- 10%.
2. The control voltage between the indoor and outdoor unit shall be 16VDC non-shielded, stranded 2 conductor cable.
3. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one outdoor unit with one 2-cable wire, thus simplifying the wiring operation.
4. The control wiring lengths shall be as shown below.

	Outdoor to Indoor Unit	**Outdoor to Central Controller**	**Indoor Unit to Remote**
Control Wiring	6,665 ft	3,330 ft	1,665 ft
Wire Type	16 AWG, 2 wire, non-polarity, non-shielded,		

BRANCH SELECTOR BOX FOR VRV HEAT RECOVERY SYSTEM

A. General:
1. The branch selector box shall consist of three electronic expansion valves, refrigerant control piping and electronics to facilitate communications between the box and main processor and between the box and indoor units. The branch selector box shall control the operational mode of the subordinate indoor units. The use of three EEV's ensures continuous heating during oil return and defrost, rapid heating/cooling changeover and reduced sound levels.
2. If solenoid valves are utilized in lieu of EEV's for changeover and pressure equalization, a double wall sound attenuation box shall be installed around each branch controller box to reduce refrigerant noise during changeover.
3. Use of multi-port branch selector boxes shall only be acceptable if no common valves are shared within the box. If manufacturer's branch controller box contain valves that are common between multiple different fan coil units, and individual box must be provided per each fan coil.
4. If manufacturer's branch controller box requires a condensate drain, a secondary

drain pan with condensate pump and overflow shut down switch shall be provided. The condensate switch shall be interlocked with all downstream fan coils to prohibit operation in cooling when an overflow condition has been sensed.

5. These selector boxes shall be factory assembled, wired, and piped.
6. These branch controllers must be run tested at the factory.
7. These selector boxes must be mounted indoors.
8. When simultaneously heating and cooling, the units in heating mode shall energize their sub-cooling electronic expansion valve.

B. Unit Cabinet:

1. These units shall have a galvanized steel plate casing.

2. The cabinet shall contain one sub-cooling heat exchanger per branch.
3. The unit shall have sound absorption thermal insulation material made of flame and heat resistant foamed polyethylene.

C. Refrigerant Valves:
1. The unit shall be furnished with 3 electronic expansion valves per branch to control the direction of refrigerant flow. The use of solenoid valves for changeover and pressure equalization shall not be acceptable due to reliability, noise, and delays due to pressure equalization. For boxes that use solenoid valves, the following criteria must be met:
   a. Spare boxes must be provided to the owner for each box supplied.
   b. Sound attenuating enclosures should be provided to meet the specified sound levels. 3rd party testing must be provided showing operating and change-over sound.
2. The refrigerant connections must be of the braze type.

D. Electrical:
1. The unit electric al power shall be 208/230 volts, 1 phase, 60 hertz.
2. The unit shall be capable of operation within the limits of 187 volts to 253 volts.
3. The minimum circuit amps (MCA) shall be 0.1 and the maximum over current protection amps (MOP) shall be 15.
4. The control voltage between the indoor and condensing unit shall be 16VDC non- shielded 2 conductor cable

DDC CONTROL SYSTEM

A. Auto-Changeover:
1. Auto-changeover shall be programmed to allow for the optimal room temperature to be maintained by automatically switching mode between Cool and Heat in accordance with the room temperature and setpoint**.**
2. The setpoint differential should adjustable between 0°F to 13°F. The (Thermal) Differential is the tolerance for the indoor unit's setpoint.
3. The operational mode shall change from cooling to heating when the room setpoint is exceeded by 1°F (adjustable).
4. The operational mode shall change from heating to cooling when the room temperature drops 1°F (adjustable) below setpoint.
5. A guard timer (adjustable 15-60 minutes) should be in place to prevent rapid changing, but is overridden if the room setpoint is changed.

B. Zone Controllers
1. The Remote controller shall feature a Backlit LCD Display with contrast adjustment and auto off after 30 seconds.
2. Multiple display modes must be available: Detailed, Standard, and Simple
3. Zone controllers must have the capability of individual function button lockout (On/Off, Mode, Fan Speed, Up/Down/Left/Right Arrows)
4. Controller Face Plate must be available as an option to hide unnecessary (locked out) buttons. Face plate and simplified display mode shall enable the user full control of the system with minimum amount of user input.
5. The following is available to display errors and to assist service personnel in troubleshooting:
   a. A blinking LED will signal system abnormality/error
   b. Error codes will be displayed in the event of system abnormality/error directly on zone controller
6. Service personnel shall be able to access the following from the room controller:
   a. Return Air Temperature

b. Liquid Line Temperature
c. Gas Line Temperature
d. Discharge Air Temperature (depending on unit)
E. Remote Controller Sensor

PART 3.EXECUTION

3.1 INSTALLATION

A. The VRV system shall be installed per Manufacturer's Installation Instructions.

3.2 START-UP

A. Start-up. Test, and adjust system in accordance with manufacturer's start-up instructions.

B. Check and calibrate controls.

3.3 SEQUENCE OF OPERATIONS

A. Variable Refrigerant Flow System: Variable refrigerant flow system shall consist of indoor fan coil units, heat / cool branch selector boxes and outdoor heat recovery units with a minimum of two compressors per module.

1. Occupied Mode

a. Heat recovery unit shall run a startup of the unit using PI control to equalize the system pressure and reducing start load. Inverter ON to charge capacitor.
b. Compressor shall start and ramp to maintain load based on PI control
c. Multiple compressors shall start based on load and PI step control.
d. Heat recovery units and compressors on multiple units will rotate starting to equalize run time.
e. Unit shall be equipped with multiple outdoor fans that step modulate on PI control to maintain head pressure.
f. Heat recovery unit shall use PI control to maintain heating availability during the cooling mode to allow for heat recovery operation.
g. Heat recovery unit shall use two condenser coils per unit to allow for heat rejection between the indoor and outdoor units during heat recovery using PI control.
h. Fan coils shall operate in heating or cooling mode to maintain space set point.

2. Defrost Mode when Occupied

    a. Heat recovery unit shall perform defrost during the heating operation without disruption of the heating cycle
    b. Indoor fans shall remain on and never shut off during defrost mode.
    c. Heating operation shall stay operational during oil recovery.
    d. Condenser coils shall defrost independently and the heating operation shall stay operational.
    e. Heat recovery unit shall have multiple outdoor fan motors PI step controlled to maintain head pressure during defrost

3. Oil Recovery Mode when Occupied

    a. If anytime during operation, the heat recovery unit reaches eight hours of operation in heating or cooling, the unit will perform an oil recovery cycle without disruption of heating cycle.
    b. Indoor fans shall remain on and never shut off during oil recovery.
    c. Heating operation shall stay operational during oil recovery.
    d. Oil recovery cycle shall last between three and five minutes.

4. Unocuppied Mode

   a. During the unoccupied cycle the heat recovery unit shall cycle to maintain setpoint in heating or cooling based on demand from onboard DDC controls as required by indoor fan coil setback temperatures.
   b. Heat recovery unit function shall be the same as occupied, defrost and oil recovery
   c. Pump down operation will be available to remove refrigerant from evaporator coils prior to shutdown.

5. Safety Devices:

   Heat recovery unit shall be equipped with the following safety devices.
   a. High pressure safety operation.
   b. Low pressure safety operation
   c. Discharge pipe protection control.
   d. Inverter protection control
   e. Standard compressor overload protection.

   f. Heat recovery unit shall be capable of back up operation in event of a compressor failure (multiple condenser application with multiple compressors

END OF SECTION 238129

SECTION 238216 – MECHANICAL AIR COILS

GENERAL

DESCRIPTION OF WORK

Electric Reheat Coils

Hot Water Heating Coils

RELATED DOCUMENTS

American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., ASHRAE: Comply with ASHRAE standards for testing of forced-circulation air-cooling and air-heating coils.

Sheet Metal and Air Conditioning Contractors' National Association, Inc., SMACNA: Comply with SMACNA standards for coil casing construction and with installation instructions.

QUALITY ASSURANCE

Protect HVAC coils from damage during shipping, storage and handling.

Avoid crushing or bending fins and prevent dirt and debris from entering or settling on coils.

Store coils inside and protect from atmosphere and construction work traffic.

SUBMITTALS

Submit in accordance with Division 1, Section 01340.

Product Data:

Submit manufacturer's installation instructions

Submit manufacturer's descriptive literature and repair data

Submit manufacturer's capacity data for each coil scheduled on drawings

EQUIPMENT

HOT WATER HEATING COILS:

Heating coil capacities and control requirements shall be as scheduled or specified. Maximum face velocity for all hot water heating coils shall not exceed 500 fpm unless noted otherwise.

Coils shall have non-ferrous fins mechanically bonded to copper tubes. Coils shall be pitched to provide for drainage and shall be designed for 125 psi and factory tested at 400 psi hydrostatic pressure and performance ARI certified.

Coil section shall be mounted in a galvanized steel casing designed for bolting to other sections or ductwork. Provide drain and vent plugs. Each coil shall have a double bend galvanized steel side plate.

Hot water coils shall be completely self draining and the finned core shall be installed in a pre-pitched casing.

Manufacturers:

Areofin

Marlo

Heathcraft

EXECUTION

METHOD OF INSTALLATION:

Install coils as indicated in accordance with manufacturer's recommendations.

Coordinate with other work, including ductwork and piping to interface installation of coils with other work.

For drainage, pitch coils minimum 1/8 inch toward return connections, in both directions.

Support:

Support coil sections on steel channel or double angle frames and secure to casings.

Bolt casings to other section, ductwork, or unit casings. Provide air-tight seal between coil and duct or unit cabinets.

END OF SECTION 238216

SECTION 23 82 39 - UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cabinet unit heaters with centrifugal fans and electric-resistance heating coils.

1.2 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Plans, elevations, sections, and details.
2. Location and size of each field connection.
3. Equipment schedules to include rated capacities, furnished specialties, and accessories.

C. Field quality-control test reports.

D. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 CABINET UNIT HEATERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Berko.
2. Chromalox.
3. Dunham-Bush.
4. Indeeco.
5. Markel.
6. Marley Electric Heating.

B. Description: A factory-assembled and -tested unit complying with ARI 440.

1. Comply with UL 2021.

C. Heater assembly shall consist of 0.12” thick powder coated aluminum die cast part fan panel / panel grille which are mounted all of the operational parts of the heater. The front

grille shall be of the louvered type finished in polyester powder coating which resists fading and abrasion.

1. Provide with 2” semi-recess mounting frame.

D. Electric-Resistance Heating Coil: Nickel-chromium heating wire, enclosed in a steel sheath to which steel plate fins are brazed. The heating element shall cover the entire air discharge area to ensure uniform heating of all discharge air.
   1. The heater shall be equipped with a manual-reset safety limit control that will automatically shut-off heater in even of overheating due to any cause. The safety cutouts shall directly interrupt power to the elements. A red warning light will illuminate (visible at top of heater grille) to alert this control has been activated.

E. Fan and Motor Assembly: The motor and fan assembly shall be direct drive and mounted on rigid heavy gauge brackets for quiet operation. The fan shall be five-bladed aluminum. The fan motor shall be totally enclosed.
   1. Fan control shall delay startup of the fan motor until the heating elements have warmed up. It shall maintain motor operation after heating elements have been de-energized to dissipate residual heat build-up.

F. Control devices and operational sequences are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."

G. Basic Unit Controls: The unit is designed to be controlled electronically with a built-in electronic digital LCD touch screen display mounted on the grille and control board mounted on the fan panel. This control will maintain room temperatures within 1.5 degrees of setpoint. The output of heat is proportionally controlled as to how much heat is needed to satisfy the set point. Heater automatically adjusts wattage output for optimum comfort. Heater settings can be locked out for security purposes.
   1. Disconnect Switch: ON/OFF switch shall be mounted on the fan deck to disconnect single point connection to power supply for the internal electrical components, including the heating element. It will be completely concealed behind the front grille panel.

H. Electrical Connection: Factory wire motors and controls for a single field connection.

I. Capacities and Characteristics:
   1. Semi-recessed cabinet with 2” mounting frame.
   2. Fan Characteristics as listed in schedule.
   3. Heating Capacity as listed in schedule.
   4. Electrical Characteristics for Single-Point Connection as listed in schedule.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install unit heaters to comply with NFPA 90A.

B. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

C. Comply with safety requirements in UL 1995.

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 238239

SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves for raceways and cables.
2. Sleeve seals.
3. Grout.
4. Common electrical installation requirements.

1.2 SPECIFICATION FORM AND DEFINITIONS

A. Design Engineer, hereinafter abbreviated D/E shall mean the Engineering firm, Olsson Associates, 1301 Burlington, North Kansas City, MO, Telephone (816) 361-1177.

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:
   a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
   b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Metraflex Co.
   d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
3. Pressure Plates: Carbon steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items, unless otherwise noted.

B. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

D. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Size pipe sleeves to provide 0.25-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."

3.3 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 260500

SECTION 26 05 01 - UTILITY SERVICE COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Collaboration with Utility company for electrical services
2. Primary/Secondary conduit
3. Drop poles / Rigid Conduit / Stand-off brackets for overhead services
4. Concrete pads for pad-mounted utility transformers
5. Utility company incurred fees and charges

B. The general intent of this specification is to set for the standards and requirements for the contractor to coordinate all electrical services as shown on the plans. It shall be the responsibility of the contractor to coordinate the EXACT requirements with Evergy prior to any work and include with the bid. The contractor shall also include all charges and fees incurred by the utility company to complete the service installation per the allowance noted.

1.2 Evergy

A. The contractor shall contact Evergy and arrange for electrical services as indicated on the drawings. Include all costs and associated fees for electrical service, as required by the utility company, in the base bid for the project, whether specifically noted on the drawings or not. All fees for connection and installation of the electrical service are the responsibility of the contractor. Where a discrepancy may occur between the drawings and what is required by the utility company, include the costs for the more expensive case and notify A/E. THIS DOES NOT INCLUDE SECONDARY VAULT WORK WITH NEW SECONDARY FEEDERS, INSTALLATION OF NEW UTILITY TRANSFORMER PAD, AND CONDUITS FOR ANY METERING.

B. For the bid, the contractor shall include all costs, charges, fees, etc. for the entire job for cost associated with the construction, charges, fees, etc charged by Evergy for the changes and the new electrical transformer (pad mounted). Contractor to provide all billings to the owner and the contract to be adjusted for actual charges incurred.

C. Overtime and shift work should not be excluded to follow the scope of work, method of procedures, etc. as outlined in the specifications and plans. The new / revised service downtime periods should be reduced to as short as possible. Extra personnel and/or hours outside of normal business hours are necessary in order to not disrupt daily operations of the facilities. Exceeding a business scheduled 40 hour work week should not be applicable to the base bid and should be taken into account from the company internally.

1.3 COORDINATION ITEMS

A. The contractor shall provide all trenching and backfill on the primary and secondary side – refer to the architectural specifications for compaction requirements. Primary

conductors shall be provided by utility company. All primary conduits may be required to be encased with concrete, confirm with Evergy. Provide as a minimum (2) 4" Rigid Metallic conduits.

B. Provide long-radius elbows for all service conduits. Verify all termination locations for the transformers and splice cabinets (or drop poles) with the utility company prior to any installation.

C. For overhead services, provide rigid conduit at the drop power pole at the location of the overhead primary location designated by Evergy.

D. For underground services, the pad-mounted transformer shall be provided by utility company. Confirm all metering requirements (CT enclosure if required) and secondary service up into transformer with the utility company. The transformer pad shall be by E/C per Evergy standards and on drawing details.

E. All secondary conduit, conductors, trenching and backfill shall be by the contractor.

F. CT cabinet at the building shall be furnished by electrical contractor and follow Evergy guidelines for make/model (Ericsson).

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

Not Used.

END OF SECTION

SECTION 26 05 02- TEMPORARY ELECTRICAL FACILITIES

GENERAL

DESCRIPTION OF WORK

Furnish temporary electrical facilities to provide lighting and power for construction. Temporary power must be installed in accordance with the National Electrical Code, National Electrical Safety Code, local utility, local codes and authority having jurisdiction.

Coordinate temporary electrical facilities with other trades.

Work or cost not included in the Section:

Electrical energy cost during construction period.

Circuits for equipment requiring either heavy current or special voltages (Negotiate directly between this Division and other Divisions requesting special services).

Circuits for exterior lighting

Relocation of temporary wiring after installation

Wiring not specified below.

TEMPORARY UTILITIES, SERVICES AND CONNECTIONS

The Contractor shall provide temporary electric power for construction purposes in accordance with all Codes and Ordinances and as required by projects. All temporary equipment, materials and connections required for the temporary services shall be furnished and installed by the Contractor. At the completion of the project or at such time as the temporary services are no longer needed, the Contractor shall remove all temporary equipment, materials, and connections and shall restore facilities to permanent finished conditions. Contractor may obtain temporary service from the existing building.

Temporary wiring connections and facilities shall be installed as required, so that all spaces, fixtures, devices, equipment, and circuits that are required to stay in operation do so, and so that interruptions in the use of any space, device, fixtures or piece of equipment can be held to the absolute minimum time possible.

Interruptions in existing utilities, services, or in the electrical circuitry and facilities shall be scheduled and sequenced, and sequencing shall conform to specific requirements as specified in other sections of the specification or as indicated on the drawings. The scheduling and sequencing shall be coordinated in advance with the Owner and Engineer and shall be as approved by these parties. Even though a schedule is approved, the Owner shall also be notified immediately prior to any interruption in any electric facilities and circuits so that alternative arrangements can be made.

PRODUCTS

MATERIALS

General: Provide new or used materials and equipment suitable for intended use. Ensure safe, adequate performance of facilities in accordance with governing regulations. Used equipment shall be in good, safe working order.

EXECUTION

INSTALLATION AND OPERATION

Except for self-contained facilities, connect and terminate temporary electrical facilities at locations required for proper distribution.

Do not subject electrical facilities on either temporary work or temporary use of permanent work to excess demand or overload.

SERVICE CONNECTION

Obtain temporary service from Power Company. Install service in conformance with NEC 230.

Include charges of Utility Company for temporary service connection. Pay all "Connect and disconnect charges of Utility Company".

GROUNDING

Edit below for non-AT&T projects. Coordinate with Owner and Architect

Power service and distribution system shall be properly grounded in accordance with NEC requirements.

Ground the system neutral in accordance with NEC 250.

Provide feeders and branch circuits with ground wire sized per NEC 250-95. The raceway system is not acceptable as a grounding means.

POWER SYSTEM AND DISTRIBUTION

Provide required distribution and capacity of system. Over-current protection, fusible and/or circuit breakers sized per NEC.

For 120/240 volts, single phase system; use 3-wire 120/240-volt feeders and branch circuits.

For 120/208 volt, 3 phase, 4-wire system; use 120/208 volt balanced single phase 3-wire distribution or 120/208 volts, 3 phase, 4-wire distribution.

For 480 volt, 3 phase, 3-wire distribution system; use balanced 2-wire single phase or 3-wire, 3 phase feeders for step-down to 120/240 volt or 120/208 volt utilization.

For 277/480 volt distribution system; use balanced 2-wire single phase or 3 and 4-wire, 3 phase feeders for step-down to 120/240 volt or 120/208 volt utilization.

Step-down transformers inside building shall be dry-type construction; protect from weather and construction damage.

Use No. 12 wire for branch circuits less than 100 feet to last outlet, and No. 10 wire for circuits beyond 100 feet. Install branch circuits using NEC approved wiring methods.

Balance loads connected to 3 phase services within reasonable limits.

PLUG-IN RECEPTACLES

Use 20A, duplex, NEMA grounded type or as required for special equipment.

Branch circuits feeding receptacles shall be 20A or as required for special equipment.

Provide receptacles to be reached by 50-foot extension cord.

All receptacle circuits shall be protected by dynamic type ground-fault circuit interrupters, which automatically disconnect circuit when leakage current of 4-6mA is detected.

Receptacles shall not be placed on the same circuit with temporary lighting.

TEMPORARY LUMINARIES

Provide luminaries approved by NEC for temporary construction wiring.

Lamps shall be rough service incandescent 150 watt to 300 watt equipped with guards to protect from contact and damage (sizes as directed).

For estimating purposes, figure total number of light sockets as follows:

One for every 300 sq. ft. of interior rooms

One for every 750 sq. ft. of exterior rooms with windows

Exterior rooms, which contain windows with room depth less than 10 feet from exterior wall, require no socket. Exterior rooms more than 10 feet deep calculated by excluding exterior 10-foot bay.

Fluorescent luminaries may be used at contractor's option.

LAMPS AND REPLACEMENTS

Provide lamps.

Replace burned out lamps to maintain required lighting levels throughout the duration of the project.

INSTALLATION OF CIRCUITS

Install required lighting and receptacle circuits along a route least objectionable to construction work as determined by Contractor. Protect circuits where exposed to damage.

PERMANENT WIRING SYSTEM

Do not use permanent wiring for construction without specific acceptance of Consultant. Before using permanent wiring for temporary service, submit a list of uses to Consultant. Consultant may refuse use of permanent equipment for temporary service. Use of permanent equipment prior to Substantial Completion shall not affect warranty period.

REMOVAL AND RESTORATION

Temporary wiring shall be removed immediately upon completion of construction or purpose for which the wiring was installed. Repair or replace work damaged by temporary electrical facilities. Clean and restore permanent electrical system used to provide temporary services to condition of new and unused work.

Electrical work installed as temporary facilities, upon removal, remains property of Installer.

Replace lamps of permanent light fixtures used for temporary lighting, which have burned out or are noticeable dim. All permanently installed fixtures in the construction area lamps shall be removed and cleaned.

Where temporary use of lamps exceeds 50 percent of lamp life, replace lamps.

At Substantial Completion, clean permanent electrical work used as temporary facilities. Remove debris accumulated in electrical spaces.

END OF SECTION 260502

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.
3. Sleeves and sleeve seals for cables.

1.2 GENERAL

A. Wires (Single Conductor) and Cables (Multi-conductor Assemblies) used for the following applications:

Power: 480/277V and 120/208V Systems

Lighting: 480/277V and 120/208V Systems

Control: 120V

Low Voltage Control & Instrumentation

Wiring Connectors and Connections

Grounding and DC Cabling

1.3 SUBMITTALS

A. Submit in accordance with Division 1, Section 01300.

B. Product Data: Submit manufacturer's technical product data, including specifications and installation instructions.

1.4 QUALITY ASSURANCE

A. Codes and Standards:

1. NFPA 70: National Electrical Code

2. UL 83: Thermoplastic Insulated Wire

3. UL 1063: Machine Tool Wire

UL 44: Rubber Insulated

UL 854: Service Entrance Cables

1.5 Acceptable Manufacturers:

A. POWER, LIGHTING and 120 VOLT CONTROL

1. American Insulated Wire

2. Essex-Paranite Cable
3. Rome Cable

B. LOW VOLTAGE CONTROL & INSTRUMENTATION

1. *Alpha*
2. *Belden*
3. *Dekoron*

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Copper Conductors: Comply with NEMA WC 70.

B. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN.

C. Multi-conductor Cable: Comply with NEMA WC 70 for metal-clad cable, Type MC with ground wire.

2.2 POWER, LIGHTING, & 120V CONTROL

A. NEC Type THHN/THWN (90°C Dry/75°C Wet)

B. Single conductor, stranded (all sizes), soft annealed copper conductors with 600 volt thermoplastic insulation and nylon jacket.

C. Wire smaller than No.12 gauge shall not be used unless specifically called for on drawings or in specifications. All emergency lighting branch circuit wire from emergency panels shall be No. 10 AWG.

D. Wire insulation shall be color coded as follows:

277/480V, 3 phase, 4 wire

Phase A	Brown
Phase B	Orange
Phase C	Yellow
Neutral	Gray
Ground	Green

120/208V, 3 phase, 4 wire

Phase A	Black
Phase B	Red
Phase C	Blue
Neutral	White

Ground Green

E. Black insulation is acceptable for #8 wire or larger. Conductor ends shall be wrapped with colored tape as indicated above.

2.3 LOW VOLTAGE CONTROL AND INSTRUMENTATION

A. Application: Conductor operating voltage shall not exceed 50-volts.

1. Shielded single twisted pair, 600V, 90-degree C:
   a. Conductors-16 AWG, stranded copper
   b. Conductor insulation of PVC with a nylon jacket
   c. Foil shield with tinned copper drain wire
   d. Black PVC outer jacket
   e. Wire insulation color coded black and white
   f. Dekoron #IC 52-67000 or equal

2. Shielded three-conductor, 600V, 90-degree C:
   a. Conductors-16 AWG, stranded copper
   b. Conductor insulation of PVC with a nylon jacket
   c. Foil shield with tinned copper drain wire
   d. Black PVC outer jacket
   e. Wire insulation color coded black, white, and red
   f. Dekoron #IC 62-67000 or equal

3. Overall shielded, multiple pairs, 600V, 90-degree C:
   a. Conductors-18 AWG, stranded copper
   b. Conductor insulation of PVC with a nylon jacket
   c. Foil shield with tinned copper drain wire
   d. Black PVC outer jacket
   e. Wire insulation color coded black, white, and numbered
   f. Dekoron or equal #IC 70-80400: 4 pair
   g. #IC 70-80800: 8 pair

4. Overall shielded, multiple conductor; 600V, 90-degree C:
   a. Conductors-14 AWG, stranded copper
   b. Conductor insulation of PVC with a nylon jacket
   c. Foil shield with tinned copper drain wire
   d. Black PVC outer jacket
   e. Wire insulation color coded black with printed number and color.
   f. Dekoron or equal
   g. #IC 99-40500-001: 5 conductor
   h. #IC 99-40900-002: 9 conductor
   i. #IC 99-41200-002: 12 conductor

B. Cables shall pass the U.L. 1581 Vertical Tray Flame Test, and be listed as Tray Cable under U.L. 1277 and in accordance with NEC Articles 318, 340, and 501.

C. Ground conductors connected to structure shall be connected with non-metallic approved fasteners.

2.4 CONNECTORS AND SPLICES

A. A. Provide UL-listed factory-fabricated wiring connectors of size, ampacity rating, material, type and class for application and for service indicated. Select connectors to comply with Project's installation requirements and as specified in Part 3 "Applications" of this Article.

B. For Conductors #10 AWG and Smaller: Wire and cable connectors shall be solderless, twist on, 600 volts, 105°C., shall comply with UL 486A/C standards. Connectors coded for easy selection compatible with wiring to be spliced. Install connectors as recommended by manufacturer. Use proper crimping tool where crimp sleeves are used.

2.5 Acceptable Connector Manufacturers:

A. 3M- "Scotchlock"

B. Buchanan - "B Cap"

C. Thomas & Betts - "Stak-On"

D. Ideal - "Wing Nuts"

E. Mechanical splices and tap connectors for feeder conductors shall be mounting block type, insulated with clamp-on molded covers that accommodate the lug types specified herein.

F. Acceptable Mechanical Connector Manufacturers:
   1. Burndy Engineering Company
   2. O-Z Gedney
   3. Thomas and Betts

G. Compression Splices: Splice conductor #8 and larger with solid copper barrel, type fittings applied with an appropriate hydraulic tool. Splices used only where approved. Splice fittings: Burndy "Hydent". Insulate splices with 600 volt, 105°C, "heat shrink",

"cold shrink" covers, or taped insulation consisting of rubber, friction and vinyl tapes applied per manufacturer for 600 volt, 105°C covering.

H. Acceptable Splice and Tape Manufacturers:
1. Burndy
2. Thomas & Betts
3. Ilsco
4. Anderson
5. Blackburn
6. Oz/Gedney

I. Connectors and/or Terminations for Conductors #6 AWG and larger: Tin plated, 98% copper, dual crimp long barrel compression lugs with two bolt holes, insulated with molded covers to accommodate 1/2" bolts. Apply with hydraulic tool recommended by manufacturer.
   1. Acceptable Manufacturers and Products
      a. O-Z Gedney
      b. Burndy Engineering Company "Hylugs"
      c. Thomas and Betts, "Color Keyed"
      d. Anderson

J. Use pulling lubricant which will not be detrimental to insulation of conductors indicated by published user information.
   1. Acceptable Manufacturers of Lubricant:
      a. Ideal Industries
      b. Panduit Corp.
      c. OZ/Gedney
      d. Plymouth/Bishop
      e. American Polywater Corp.
      f. Thomas & Betts

K. Insulate all live joints to 600 volts with strip rubber, friction tape, and electrical vinyl tape installed in accordance with manufacturer’s recommendations.
   1. Acceptable Tape Manufacturers:
      a. 3M
      b. Plymouth

L. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

M. Install splice and tap connectors which possess equivalent or better mechanical strength and insulation rating than conductors being spliced. For conductors #8 AWG and smaller, splice and tap connectors shall be spring connectors with molded vinyl caps. For conductors #6 AWG and larger, splice and tap connectors shall be split-bolt or compression type installed with hydraulic tool of proper capacity as recommended by the manufacturer for the size of conductor on which the connector is used.

N. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than #10 AWG cabled in individual circuits. Make terminations so there is no bare conductor at the terminal.

O. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torqueing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B.

P. Induction motors are to be terminated with bolted pressure connections and insulated with varnished cambric, then Scotch 130C rubber tape and covered with a minimum of three laps of scotch 33+ electrical tape.

2.6 SLEEVES FOR CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.7 SLEEVE SEALS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide Metraflex Co. or a comparable product by one of the following:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Pipeline Seal and Insulator, Inc.
4. Metraflex.

C. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Stainless steel. Include two (2) for each sealing element.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.1 GENERAL

A. Install electrical conductor, cables, wires, and connectors in compliance with NEC.

B. All wires shall be run in conduit or cable tray as indicated.

C. All terminations and splices shall be made in accordance with proper methods and recommendations for the type of wire and devices used and as recommended by the manufacturers of material and equipment involved.

D. Splice and tap connectors for conductors #8 AWG and smaller shall be 3-M "Scothlok" or Ideal Industries "Super-Nut" spring connectors with molded vinyl caps.

E. Splice and tap connectors for conductors #6 AWG and larger shall be compression type installed with hydraulic tool of proper capacity as recommended by the manufacturer for the size of conductor on which the connector is used. Connector size shall be selected in accordance with manufacturer's recommendations for the size and number of wires or cables on which the connector is used.

F. All terminating connections for conductors size #6 AWG and larger shall be made with two-hole hydraulic compression type lugs.

G. Pull conductors simultaneously where more than one is being installed in same conduit. Use UL listed pulling compound or lubricant, where necessary, unless indicated otherwise in this specification or on drawings.

H. Use splice and tap connectors which are compatible with conductor material.

I. Provide adequate length of conductors within electrical enclosures and neatly train the conductors to terminal points with adequate excess. Bundle multiple conductors, with conductors larger than #10 AWG cabled in individual circuits. Make terminations with no bare conductor showing at the terminal.

J. Prior to energizing, check installed wires and cables with megohm meter to determine insulation resistance levels to assure requirements are fulfilled.

K. Prior to energizing, test wires and cables for electrical continuity and for short-circuits.

L. Subsequent to wire and cable hook-ups, energize circuits and demonstrate proper functioning. Correct malfunctioning units, and retest to demonstrate compliance.

M. Clean conductor surfaces before installing lugs and connectors.

N. Make splices, taps and terminations to carry full ampacity of conductors with no perceptible temperature rise.

O. Use split bolt connectors for copper conductor splices and taps, #6 AWG and larger; tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.

P. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, #8 AWG and smaller.

Q. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, #10 AWG and smaller.

3.2 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper for feeders smaller than No. 4 AWG; copper for feeders No. 4 AWG and larger. Solid or stranded for No. 10 AWG and smaller; stranded for No. 8 AWG and larger. Sizes noted on drawings are for copper.

B. Branch Circuits: Copper. Solid or stranded for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Use no conductors smaller than No. 12 gauge unless specifically called for or approved by Design Engineer. Size wire for 120 volt branch Circuits for 3% maximum voltage drop. Size feeder circuits for 2 percent maximum voltage drop. Combined voltage drop of feeders and branch circuits shall not exceed 5 percent maximum.

3.3 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Wire in conduit shall be cross-linked polyethylene type XHHW.

B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW, single conductors in raceway.

D. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

F. Branch Circuits, below Slabs-on-Grade, and Underground: Type XHHW, cross-linked polyethylene.

G. Class 1 Control Circuits: Type THHN-THWN, in raceway.

H. Class 2 Control Circuits: Type THHN-THWN, in raceway Power-limited cable, concealed in building finishes.

3.4 INSTALLATION OF CONDUCTORS AND CABLES

A. Run conductors in conduit continuous between outlets and junction boxes with no splices or taps pulled into conduits.

B. Neatly route, tie and support conductors terminating at switchboards, motor control centers, panelboards, sound equipment, etc., with Thomas & Betts Ty-Rap cable ties and clamps or equivalent by Electrovert or Panduit.

C. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

D. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

E. Provide factory-applied nylon or PVC external jacketed wires and cables for pulls in raceways over 100-feet in length, for pulls in raceways with more than three equivalent 90° bends, for pulls in conduits underground or under slabs on grade, and where indicated.

F. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

G. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

H. Support cables according to Division 26 Sections "Hangers and Supports for Electrical Systems."

I. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

J. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

K. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
2. Make circuit conductor splices with Buchanan B-Cap nylon insulated connectors or equivalent by Ideal or 3M.
3. Make fixture and device taps with Scotchlock self-stripping electrical tap connectors.
4. Terminate solid conductors at equipment terminal strips and other similar terminal point with insulated solderless terminal connectors. Terminate all stranded conductor terminal points with insulated solderless terminal connectors. Provide Thomas & Betts Sta-Kon insulated terminals and connectors or equivalent by API/AMP Blackburn, Buchanan or Scotchlock.

5. Where a total of six or more control and feeder conductors terminate in a multiple device panel or enclosure that has no built-in terminal blocks, provide mounting channel and see-thru covers. Equivalent terminal blocks by General Electric, Square D or Westinghouse.
6. Wrap conductor taps and connections requiring additional insulation with a minimum of three (3) overlapped layers of 3M Scotch vinyl plastic electrical tape No. 88 or equivalent.

L. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

M. No wiring or conduit shall be placed in the concrete slab.

N. All cables 24VDC and under shall be installed in cable tray or conduit. Any conductors operating above 24VDC to be in conduit.

3.5 FIELD QUALITY CONTROL

A. Prior to energizing, check installed wires and cables with megohm meter to determine insulation resistance levels.

B. Prior to energizing, test wires and cables for electrical continuity and for short circuits.

C. Subsequent to wire and cable hookups, energize circuits and demonstrate proper functioning. Correct malfunctioning units, and retest to demonstrate compliance.

D. Color code secondary service, feeder, and branch circuit conductors with factory applied color as follows: For conductors #8 and larger, provide a minimum of 10 wraps of color coded vinyl tape within 6” of conductor termination points or color coded insulation.

3.6 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

D. Cut sleeves to length for mounting flush with both wall surfaces.

E. Extend sleeves installed in floors 2 inches above finished floor level.

F. Edit paragraph below as required for Project design conditions and seismic-criteria status.

G. Size pipe sleeves to provide 0.25-inch annular clear space between sleeve and cable unless sleeve seal is to be installed.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 07 Section "Joint Sealants."

J. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.

K. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

3.7 SLEEVE-SEAL INSTALLATION

A. Install to seal underground exterior-wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.8 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

END OF SECTION 260519

SECTION 26 05 23 - CONTROL WIRING AND DEVICES

GENERAL

WORK INCLUDES

Wire and Cables for Control Systems

Control Interlock Wiring

Field Fabricated Control Panels

Relays

Switches

Control circuits & Motor Control

SUBMITTALS

Submittals shall be made on all items in this section and shall be in accordance with the Division 1 - General Conditions.

Product Data: Submit manufacturer's technical product data, including specifications and installation instructions, for each type of wire or cable system required. Include data substantiating that materials comply with requirements.

Maintenance Data: Submit maintenance data and parts lists for each type of wire or cable system installed, including furnished specialties and accessories. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of the General Provisions of this Specification.

PRODUCTS

CONTROL WIRING

The Contractor shall provide all control wiring and connections required for a complete an operable system as specified herein and as shown on drawings. All materials and installation shall comply with requirements specified in the National Electrical Code and all applicable state and city codes and regulations.

Control interlock and remote indication wiring shall be #14 AWG type "THHN", except runs greater than 200 feet in length shall be #12 AWG unless noted otherwise on drawings.

Splice and tap connectors for conductors shall be 3-M "Scothlok" or Ideal Industries "Super-Nut" spring connectors with molded vinyl caps. Connector size shall be selected in accordance with manufacturer's recommendations for the size and number of wires or cables on which the connector is used.

Contractor shall provide all control wiring and connections required for control systems. The wiring shall include the furnishing and installation of all wire, conduit, boxes, and all other necessary materials and devices required for a complete and operable installation. All materials and installation shall comply with requirements as specified herein. All wire for control circuitry shall be installed in rigid EMT conduit system and all splices and connections shall be made in boxes or device or equipment enclosures.

Low voltage (25 volts and under) control wiring shall not be installed in the same conduit with higher voltage circuitry wiring. Where low-voltage wiring enters the same box or enclosure with higher voltage wiring, dividers, and separation shall be provided to comply with codes and regulations, and as required to prevent malfunctions in low voltage control. Where separation of conductors for certain functions or control is recommended by the equipment or system manufacturer, then the conductors for these functions or control shall be installed in conduit separate from other conductors, regardless of voltage differential.

Power and 120VAC control wiring shall be single conductor, stranded (all sizes) soft annealed copper conductors with 600 volt insulation. Type THHN/THWN, Gasoline & Oil Resistant, VW-1, 75 degree C., unless noted or specified otherwise; wire smaller than No. 14 gauge shall not be used unless specifically called for on drawings.

Control and instrumentation 24V wiring shall be shielded twisted pair, 600V, 90-degree C:

Conductors-18 AWG, stranded copper

Conductor insulation of 15 mils PVC and 5 mils nylon

Foil shield with tinned copper drain wire

Jacket of 50 mil Black PVC

Wire insulation color coded black and white

All control wiring shall be in accordance with color coding as shown on drawings and/or indicated below:

Blue: DC control wiring

Red: AC control wiring

White: 120 VAC neutral

Green: Equipment ground

Black: 120 VAC power wiring (hot)

Yellow: All control circuits or wiring which may remain energized when the main disconnecting means is in the off position

Black and Clear: Shielded cable

CONTROL EQUIPMENT

General Requirements:

All electromechanical control equipment shall be housed in a control panel as specified below.

Screw-type terminals with captive saddle straps or equivalent means of retaining stranded conductors shall be provided on control devices and terminal strips.

Control devices shall be marked in accordance with requirements as specified in Section 260553 and as shown on drawings.

Control contacts shall be of the quick-make/quick-break type.

Limit switches, pressure switches and similar devices shall have separate, isolated normally open and closed contacts, as indicated within these specifications

Control relays shall be four-pole minimum, eight-pole installed maximum, unless noted or indicated otherwise on the drawings. Relays shall have a complete set of contacts (e.g., a four-pole block shall have all contacts furnished). Control relays shall be insulated for 600 volts unless specified otherwise in other Divisions of this specification.

The mounting details of all control devices shall not be modified from the manufacturer's standard mounting dimensions and practices.

Plug-in devices and assemblies shall be mechanically secured.

CONTROL PANELS

Type: Provide control panels with suitable brackets for either wall or floor mounting at locations indicated on contract drawings. Locate panel adjacent to systems served; panels to be of standard steel, as required to contain temperature controllers, relays, switches, etc., totally enclosed, with hinged door and keyed lock; panel to be shop-painted with manufacturer's standard finish and color. Provide UL-listed cabinets for use with line voltage devices.

Electrical requirements: Provide electric pneumatic or pneumatic-electric switches, electrical devices, and relays that are UL-listed, and of the type which meet current and voltage characteristics of the project.

Manufacturers:

Hoffman

EXECUTION

INSTALLATION

Install electrical conductor, cables, wires, and connectors in compliance with NEC.

Coordinate cable installation with other work, equipment suppliers, system manufacturers

Pull conductors simultaneously where more than one is being installed in same conduit. Use UL listed pulling compound, dry talc or lubricant, where necessary, unless indicated otherwise in this specification or on drawings.

Use pulling means including, fish tape, cable, rope, and basket weave wire/cable grips which will not damage cables or raceways. Do not use rope hitches for pulling attachment to wire or cable.

Conceal all cable in conduit.

Install cable in conduits parallel and perpendicular to surfaces or exposed structural members, and follow surface contours.

Keep conductor splices to minimum and provide not less than 8" slack conductors at outlet and junction boxes for splices.

Install splice and tap connectors which possess equivalent or better mechanical strength and insulation rating than conductors being spliced, as specified hereinbefore.

Use splice and tap connectors which are compatible with conductor material, and meet the system manufacturer’s requirements.

Provide adequate length of conductors within electrical enclosures and neatly train the conductors to terminal points with adequate excess. Bundle multiple conductors, cables and conductors larger than no 10 AWG cabled in individual circuits. Make terminations with no bare conductor showing at the terminal.

PROTECTION

This section shall apply to all equipment which operates at a supply voltage of 600 volts or less with the exception of machines powered by a single motor rated less than ¼ horsepower.

All protective devices shall be selected and applied with proper consideration of the inrush and normal operating current of the load as well as the thermal capacity and the short circuit with standability of the series connected devices and any equipment being protected by the device.

Two or more protective devices applied in series shall be selected with proper time-current and let-through energy characteristics to provide as much selective circuit protection for fault and overload conditions as possible, based on the manufacturer's data.

Time delay fuses shall be applied for current limiting, as well as, protection from nuisance blowing caused by inrush currents.

Current-limiting fuses shall be applied where the available short circuit current approaches or exceeds the momentary withstand and the interrupting capacity of the standard protective equipment.

Fuses for control wiring shall be time delay (dual element) types having a minimum interrupting rating of 120 percent of the maximum available system short circuit current. In no case shall the interrupting rating be less than 100,000 amperes rms symmetrical.

All low voltage fuses shall be high interrupting capacity (energy limiting) and Underwriters' Laboratories listed and labeled as specified hereinafter.

Loads: An overcurrent device shall be connected in series with each underground leg of all branch control circuits.

The overcurrent device rating shall be as low as practical and shall not exceed values specified in the following table for the smallest conductor in the branch circuit.

Conductor Size AWG	Maximum Rating Amperes
14	15
12	20
10	30

The control transformer shall be protected in the primary and secondary circuits against short circuits and overloads as specified in the following table.

Control Transformer Size, Volt Amperes	Maximum Secondary Ratings Amperes
150	1.06
200	2.0
250	2.05
300	3.02
500	5
750	8
1000	10
1250	12

1500	15
2000	20
3000	30
5000	50

For transformers larger than 5000 volt-amperes, the protective device rating shall be based on 125 percent of the secondary current rating of the transformer.

For primary fuse requirements, refer to NEC Section 450.

Each solenoid shall be considered as a separate branch circuit and shall have an overcurrent device rated at approximately 150 percent of the sealed solenoid current. The overcurrent device shall be connected between the solenoid and the control relay contact or output device. If a fuse is used, then it shall be a dual element indicating type. In the case of control by a semiconductor device, this fuse shall be supplied in addition to the normally fused output to provide coordination.

Under voltage protection shall be provided on all equipment which may be damaged by a continuous under voltage condition or which may initiate motion upon return of power after an under voltage condition.

CONTROL CIRCUITS

The source of the supply for the control circuit shall be taken from the load side of the main disconnecting means.

It is internal to the control panel enclosure.

The control circuit voltage shall be 120 volts AC single phase, obtained from a single transformer with an isolated secondary winding. Transformer shall have a minimum of 25% spare capacity.

Contact Rating:

Contacts on any starter, contactor or relay shall not be used in excess of its rating. Contacts shall not be connected in parallel to increase ampacity.

When surge suppressors are used to minimize electrical noise, they shall be of the diode MOV or RC type and properly rated for the application. Suppressors shall be mounted to eliminate failure of connecting leads due to vibration or exposure to physical damage.

Interlocking between equipment shall be provided as indicated on drawings and as required to meet the intent of the control sequences specified within this Division of the specifications.

Interlocks between control circuits that are not de-energized by the same disconnecting means shall have isolated contacts, and shall be labeled as such.

Auxiliary light and electrical accessories are defined as work lights, enclosure lighting and convenience receptacles which are not used as control circuit voltage sources.

The auxiliary lighting and electrical accessories supply voltage shall be 120V ac single phase and ground.

Enclosure convenience receptacles: Enclosures which house electronic equipment shall be provided with a minimum of one (1) duplex receptacle for use with support equipment. Convenience receptacles shall be located conveniently to the electronic equipment in the control enclosure.

LOCATION AND MOUNTING OF CONTROLS

Components shall be mounted to provide mechanical clearances sufficient for mounting, wiring, adjustment, testing and replacement. Each component shall be mounted to provide heat dissipation consistent with the temperature rating of the component, adjacent components and conductors. Each component shall be arranged and oriented so that the identification may be determined without moving the component or its wiring.

Equipment shall be mounted so that any component or component part can be replaced without removing the subplate. No components shall be mounted behind door pillars unless adequate space is provided for replacement and servicing.

Control components shall be front mounted on a rigid metal subplate so that the complete subplate can be removed through the enclosure opening. Subplate metal shall be a minimum of 0.106 inch (MGS No. 12) nominal for mounting components with one-quarter inch diameter screws or smaller.

The bottom of the subplate mounted device including terminal blocks shall not be less than 18 inches above the floor line. In no case shall the top of subplate mounted components be more than 84 inches above the floor line.

A minimum of 1 inch shall be provided between the subplate components and the sides of the enclosure for proper terminal wiring and maintenance access.

Subplate mounted control components shall be grouped together in one enclosure or compartment wherever possible.

Any component(s) mounted on the subplate carrying line voltage or a combination of line voltage and control voltage shall be grouped above or to the side and segregated from devices which carry only the control voltage. This does not apply where the line voltage is 120 volts.

To minimize electromagnetic interference, solid state control and its associated wiring shall be segregated from the electromagnetic control wiring.

Subplate mounted control components, such as relays, starters and contactors shall be mounted in numerical order from left to right and top to bottom.

Terminal blocks located in compartments shall not be recessed more than 4 inches from the equipment surface. Terminal blocks shall be mounted to provide an unobstructed access to the terminals and their conductors. The blocks shall not be mounted above each other in a plane perpendicular to the subplate. Terminal strips shall not be mounted in wireways.

Separately mounted terminal strips shall be used for power circuits and control circuits in all enclosures. Terminal block shall be as manufactured by Allen Bradley No. 1492-HC-6 or equal Square D, General Electric, or Cutler Hammer devices and shall be furnished in quantity as required for the specific installation.

Ten percent spare terminals shall be provided on each subplate of every electrical enclosure and compartment. A minimum of eight spare control terminals and three spare power terminals shall be provided.

Mounting for electronic subassemblies and components shall be as follows:

Plug-in assemblies shall be mechanically secured in place with captive fasteners and keyed for proper insertion.

Components shall be mounted for ease of replacement and maintenance after assembly. Controls and adjustments for maintenance personnel shall be separately located from those required by operation personnel, and shall be readily accessible.

Transducers and associated parts shall be constructed and installed in such a manner as to provide accessibility and adequate protection against mechanical damage, degradation of performance and contamination from the environment.

FIELD QUALITY CONTROL

Prior to energizing, check installed wires and cables with megohm meter to determine insulation resistance levels to assure requirements are fulfilled.

Prior to energizing, test wires and cables for electrical continuity and for short circuits.

Subsequent to wire and cable hook-ups, energize circuits and demonstrate proper functioning. Correct malfunctioning units, and retest to demonstrate compliance.

END OF SECTION 260523

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment. Provide a grounding system as required by the National Electric Code (NEC) and local authorities.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 0.25-inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1.625 inches wide and 0.0625-inch thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1.625 inches wide and 0.0625-inch thick.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel 0.75-inch by 10 feet in diameter.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid or stranded conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 3/0 AWG minimum. Bury at least 24 inches below grade.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three (3) bands of green and two bands of yellow.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits (exterior only) and (dimming circuits).
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Metal-clad cable runs.
8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
10. Connect system neutral ground and equipment ground system to common ground bus.

B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

C. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

D. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

E. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 0.25-inch by 2-inch by 12-inch grounding bus.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

F. Ground secondary services at supply side of each individual secondary disconnecting means and at related transformers in accordance with NEC. Provide each service disconnect enclosure with neutral disconnecting means which interconnect with insulated neutral and uninsulated equipment ground sub to establish system common ground point. Neutral disconnecting links shall be located so that low voltage neutral bar with interior secondary neutrals can be isolated from common ground bus and service entrance conductors.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
2. For grounding electrode system, install at least three (3) rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor. Rods shall be interconnected by a minimum 3/0 bare copper conductor brazed to each ground rod below grade.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

D. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on building side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells.
    a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method according to IEEE 81.

B. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 5 ohms.
2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm.

C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.3 QUALITY ASSURANCE

A. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Cooper B-Line, Inc.; a division of Cooper Industries.
    b. Thomas & Betts Corporation.
    c. Unistrut; Tyco International, Ltd.
2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
5. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        1) Hilti Inc.
        2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        3) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
    a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        1) Cooper B-Line, Inc.; a division of Cooper Industries.
        2) Hilti Inc.
        3) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        4) MKT Fastening, LLC.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Support vertical and horizontal conduit runs at intervals not greater than 10 feet, within 3 feet of any bend and at every outlet or junction box. Where plastic conduit is used, follow E/M's recommended hangar spacing.

C. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 0.25-inch in diameter.

D. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps.

E. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1.5-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 pounds.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4

inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.

6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions 4 inches thick or as otherwise indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete and Miscellaneous Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

D. All conduit raceways and cable trays where exposed in finish space shall be painted to match attached surface or material.

END OF SECTION 260529

SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.2 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, details, and attachments to other work.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

C. Comply with applicable requirements of UL 50, UL 514 Series, and UL 886 pertaining to electrical boxes and fittings. Provide electrical boxes and fittings which are UL listed and labeled.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Rigid Steel Conduit: Hot dipped galvanized with clear lacquer finish complying with ANSI C80.1.

B. PVC coated rigid metal conduit complying with ANSI C80.1, UL 6 and NEMA RN-1. Match existing used at for OR Isolation Panel circuits.

C. EMT: Thin wall with electro-galvanized and clear lacquer finish complying with ANSI C80.3.

D. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
2. Fittings for EMT: Steel, compression type.

2.2 NONMETALLIC CONDUIT AND TUBING

A. ENT: NEMA TC 13.

B. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.

2.3 METAL WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper B-Line, Inc.
2. Hoffman.
3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1 or 3R, as indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Flanged-and-gasketed type.

E. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Thomas & Betts Corporation.
    b. Walker Systems, Inc.; Wiremold Company (The).
    c. Wiremold Company (The); Electrical Sales Division.

B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Architect from manufacturer’s standard colors.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Butler Manufacturing Company; Walker Division.
    b. Hubbell Incorporated; Wiring Device-Kellems Division.
    c. Lamson & Sessions; Carlon Electrical Products.
    d. Panduit Corp.
    e. Walker Systems, Inc.; Wiremold Company (The).
    f. Wiremold Company (The); Electrical Sales Division.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

C. Metal Floor Boxes: Cast metal, fully adjustable, rectangular.

D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

E. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized, cast iron with gasketed cover.

F. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic finished inside with radio-frequency-resistant paint.

G. Cabinets:

1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:
   a. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   b. Mechanical rooms.
   c. Electrical rooms.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Damp or Wet Locations: Rigid steel conduit.
6. Raceways for Optical Fiber or Communications Cable: EMT.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

B. EMT Conduit shall be provided for the following application where cable is installed in occupied area without ceiling or cable tray, and in walls to above ceiling:

1. Data and telephone wiring
2. Intercom
3. Fire Alarm
4. Security System
5. Cable TV
6. DDC control wiring

C. Minimum Raceway Size: 0.75-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
2. Setscrew fittings shall not be allowed.

E. Short runs of flexible conduit may be used where permitted by code. Lengths greater than 6 feet require prior approval by engineer.

F. Plastic conduit shall not be used above grade for any purpose.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation. Provide insulated throat fittings prior to conductor installation. Failure to do so may result in re-pulling of wiring.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated. Install exposed conduit parallel or at right angles to building lines. Install all conduit in neat, workman like manner.

H. Make conduit connection to motors and equipment on resilient mounts with liquid-tight flexible conduit.

I. Where conduits cross building expansion joints, provide expansion fittings as required.

J. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Change from ENT to rigid steel conduit, before rising above the floor.

K. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

L. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

M. All below grade non-metallic conduit shall be provided with tracer wire.

N. Raceways for Optical Fiber and Communications Cable: Install as follows:

1. 0.75-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet.

2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
3. Install with a maximum of two (2) 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

O. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

P. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

Q. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

R. Set metal floor boxes level and flush with finished floor surface.

3.3 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 260533

SECTION 26 05 33.11 - FLOOR BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 CONDITIONS AND REQUIREMENTS

A. The General Conditions, Supplementary Conditions, and Division 01 – General Requirements apply.

1.2 SECTION INCLUDES

A. Resource RFB floor boxes.

1.3 RELATED SECTIONS

A. Division 26 - Electrical: Electrical systems and components.

B. Division 27 - Communications: Communications systems and components.

C. Division 28 - Electronic Safety and Security: Security systems and components.

1.4 SUBMITTALS

A. Product Data: Submit for floor boxes.

B. Shop Drawings: For the following electrical system components. Include plans, elevations, sections, details, and attachments to other work.

1. Floor boxes.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Firms regularly engaged in manufacture of floor boxes of the types and sizes required, whose products have been in satisfactory use in similar service for not less than 10 years. Provide floor boxes produced by a manufacturer listed in this section.

B. Electrical Raceways and Components: Comply with requirements of applicable local codes, NEC, UL, and NEMA Standards pertaining to raceways and components. Listed and labeled in accordance with NFPA 70, Article 100.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver floor boxes and fittings in factory labeled packages.

B. Store and handle in strict compliance with manufacturer’s written instructions and recommendations.

C. Protect from damage due to weather, excessive temperature, and construction operations.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

A. Basis-of-Design Product: The design for floor boxes and fittings is based on the Resource RFB Floor Box Series manufactured by Wiremold/Legrand, 60 Woodlawn Street, West Hartford, CT 06110; toll-free 800-621-0049, telephone 860-233-6251, fax 860-232-2062; Web Site: www.wiremold.com.

B. Substitutions will be considered under provisions of Section 01 60 00.

2.2 FLOOR BOXES

A. RFB2 Series Floor Boxes: Manufactured from stamped steel and approved for use on abovegrade floors. The box shall be 13-1/8" L x 6-1/2" W x 3-7/16" H [333mm x 165mm x 87mm]. Provide the box with two (2) independent wiring compartments that allow capacity for up to two (2) duplex receptacles, communication and audio/video services. The box shall permit tunneling from end power compartment to end power compartment. Provide each of the two (2) compartments with a minimum wiring capacity of 50 cu in [822 ml^3]. The box shall include the following number of conduit knockouts: two (2) 1/2-inch [12.7mm], six (6) 3/4-inch [19.1mm], two (2) 1-inch [25mm] and four (4) 1-1/4-inch [32mm]. The box shall be fully adjustable, providing a maximum of 1-3/8-inch [35mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics workstation connectivity outlets and modular adapters, the Pass & Seymour Network Wiring System, and other open system devices.

B. RFB2-SS Series Floor Boxes: Manufactured from stamped steel and approved for use on above grade floors. The box shall be 13-1/8" L x 6-1/2" W x 2-5/8" H [333mm x 165mm x 67mm]. Provide the box with two (2) independent wiring compartments that allow capacity for up to two (2) duplex receptacles, communication and/or audio/video services. The box shall permit tunneling from end power compartment to end power compartment. Provide each of the two (2) compartments with a minimum wiring capacity of 38 cu in [622 ml^3]. The box shall contain the following number of conduit knockouts: two (2) 1/2-inch [12.7 mm] and twelve 3/4-inch [19.1 mm]. The box shall be fully adjustable, providing a maximum of 1-3/8-inch [35mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics workstation connectivity outlets and modular adapters, the Pass & Seymour Network Wiring System, and other open system devices.

C. RFB2-OG Series Floor Boxes: Manufactured from stamped steel and painted with a fusion-bonded epoxy designed for use on metal reinforcement bar and related accessories before encapsulation in concrete, and be approved for use on grade and above grade floors. The box shall be 13-1/8" L x 6-1/2" W x 3-7/16" H [333mm x 165mm x 87mm]. Provide the box with two (2) independent wiring compartments that allow capacity for up to two (2) duplex receptacles, communication and/or audio/video services. The box shall permit tunneling from end power compartment to end power compartment. Provide each of the two (2) compartments with a minimum wiring capacity of 50 cu in [822 ml^3]. The box shall include the following number of conduit knockouts: two (2) 1/2-inch [12.7mm], six

(6) 3/4-inch [19.1mm], two (2) 1-inch [25mm] and four (4) 1-1/4-inch [32mm]. The box shall be fully adjustable, providing a maximum of 13/8-inch [35mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics workstation connectivity outlets and modular adapters, the Pass & Seymour Network Wiring System, and other open system devices.

D. RFB4 and RFB4-4DB Series Floor Boxes: Manufactured from stamped steel and approved for use on above grade floors. The box shall be 12-3/4" L x 10" W x 3-7/16" H [324mm x 254mm x 87mm]. Provide the box with four (4) independent wiring compartments that allow capacity for up to four (4) duplex receptacles, communication and/or audio/video services. The RFB4 Series Box shall permit tunneling from end power compartment to end power compartment. The RFB4-4DB Series Box shall permit tunneling from adjacent or opposite compartments. Two (2) of the four (4) compartments shall have a minimum wiring capacity of 16.4 cu in [269cu cm], one (1) compartment shall have a minimum capacity of 32.3 cu in [529cu cm], and one (1) compartment shall have a minimum capacity of 50 cu in [820cu cm]. The box shall include the following number of conduit knockouts: one (1) 1/2-inch [12.7mm], three (3) 1-inch [25mm], six (6) 3/4-inch [19.1mm], and six (6) 1-1/4-inch [32mm]. The box shall be fully adjustable, providing a maximum of 1-7/8-inch [47.7mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics® workstation connectivity outlets and modular adapters, the Pass & Seymour Network Wiring System, and other open system devices.

E. RFB4-CI-1 Series Floor Boxes: Manufactured from cast-iron and approved for use on grade and above grade floors. The box shall be 14-1/2" L x 11-7/8" W x 3-7/16" H [368mm x 302mm x 87mm]. Provide the box with four (4) independent wiring compartments that allow capacity for up to four (4) duplex receptacles and/or communication services. The box shall permit tunneling from adjacent or opposite compartments. Two (2) of the four (4) compartments shall have a minimum wiring capacity of 27 cu in [443cu cm], and two (2) compartments shall have a minimum wiring capacity of 36 cu in [590cu cm]. The box shall include the following number of conduit hubs: four (4) 1-inch [25mm] and four (4) 1-1/4-inch [32mm]. The box shall be fully adjustable, providing a maximum of 1-7/8-inch [48mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics® workstation connectivity outlets and modular adapters, and other open system devices.

F. RFB4-SS Series Floor Boxes: Manufactured from stamped-steel and approved for use on above grade floors. The box shall be 13-5/8" L x 10" W x 2-7/16" H [346mm x 254mm x 62mm]. Provide the box with four (4) independent wiring compartments that allow capacity for up to four (4) duplex receptacles, communication and/or audio/video services. The box shall permit feed through tunneling from adjacent compartments. Two (2) of the four (4) compartments shall have a minimum wiring capacity of 15.7 cu in [257cu cm], and two (2) compartments shall have a minimum wiring capacity of 31.2 cu in [511cu cm]. The box shall contain the following number of conduit knockouts: two (2) 1/2-inch [12.7mm], six (6) 3/4-inch [19.1mm], and eight (8) 1-inch [25mm]. The box shall be fully adjustable, providing a maximum of 1-7/8-inch [48mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics® workstation connectivity outlets and modular adapters, and other open system devices.

G. RFB6 Series Floor Boxes: Manufactured from stamped steel and approved for use on above grade floors. The box shall be 13-1/8" L x 12-1/2" W x 3-1/4" H [333mm x 317mm x 83mm]. Provide the box with six (6) independent wiring compartments that allow capacity for up to six (6) duplex receptacles, communication and/or audio/video services. The box shall permit feed through tunneling from adjacent compartments. Two (2) of the six (6) compartments shall have a minimum wiring capacity of 23 cu in [376cu cm], and four (4) compartments shall have a minimum wiring capacity of 52cu in [850cu cm]. The box shall contain the following number of conduit knockouts: twelve 3/4-inch [19.1mm], four (4) 1-inch [25mm], and twelve 1-1/4-inch [32mm]. The box shall be fully adjustable, providing a maximum of 1-3/8-inch [35mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics workstation

connectivity outlets and modular adapters, the Pass & Seymour Network Wiring System, and other open system devices.

H. RFB6-OG Series Floor Boxes: Manufactured from stamped steel and painted with a fusion-bonded epoxy designed for use on metal reinforcement bar and related accessories before encapsulation in concrete, and approved for use on grade and above grade floors. The box shall be 13-1/8" L x 12-1/2" W x 3-1/4" H [333mm x 317mm x 83mm]. Provide the box with six (6) independent wiring compartments that allow capacity for up to six (6) duplex receptacles, communication and/or audio/video services. The box shall permit feed through tunneling from adjacent compartments. Two (2) of the six (6) compartments shall have a minimum wiring capacity of 23 cu in [376cu cm], and four (4) compartments shall have a minimum wiring capacity of 52cu in [850cu cm]. The box shall contain the following number of conduit knockouts: twelve 3/4-inch [19.1mm], four (4) 1-inch [25mm], and twelve 1-1/4-inch [32mm]. The box shall be fully adjustable, providing a maximum of 1-3/8-inch [35mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics workstation connectivity outlets and modular adapters, the Pass & Seymour Network Wiring System, and other open system devices.

I. RFB6E Series Floor Boxes: Manufactured from stamped steel and approved for use on above grade floors. The box shall be 13-1/8" L x 12-1/2" W x 4" H [333mm x 317mm x 102mm]. Provide the box with six (6) independent wiring compartments that allow capacity for up to six (6) duplex receptacles, communication and/or audio/video services. The box shall permit feed through tunneling from adjacent compartments through 1-1/4-inch grommet openings. Two (2) of the six (6) compartments shall have a minimum wiring capacity of 23 cu in [376cu cm], and four (4) compartments shall have a minimum wiring capacity of 52cu in [850cu cm]. The box shall contain the following number of conduit knockouts: twelve 3/4-inch [19.1mm], four (4) 1-inch [25mm], and twelve 1-1/4-inch [32mm]. The box shall be fully adjustable, providing a maximum of 1-3/8-inch [35mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics workstation connectivity outlets and modular adapters, and other open system devices.

J. RFB6E-OG Series Floor Boxes: Manufactured from stamped steel and painted with a fusion-bonded epoxy designed for use on metal reinforcement bar and related accessories before encapsulation in concrete, and approved for use on grade and above grade floors. The box shall be 13-1/8" L x 12-1/2" W x 4" H [333mm x 317mm x 102mm]. Provide the box with six (6) independent wiring compartments that allow capacity for up to six (6) duplex receptacles, communication and/or audio/video services. The box shall permit feed through tunneling from adjacent compartments. Two (2) of the six (6) compartments shall have a minimum wiring capacity of 23 cu in [376cu cm], and four (4) compartments shall have a minimum wiring capacity of 52cu in [850cu cm]. The box shall contain the following number of conduit knockouts: twelve 3/4-inch [19.1mm], four (4) 1-inch [25mm], and twelve 1-1/4-inch [32mm]. The box shall be fully adjustable, providing a maximum of 1-3/8-inch [35mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics workstation connectivity outlets and modular adapters, and other open system devices.

2.3 ACTIVATION COVERS

A. FloorPort FPCT, FPBT, and FPFFT Series Covers: Manufactured of die-cast aluminum or die-cast zinc, and available in brushed aluminum finish and powder-coated paint finishes (black, gray, bronze, nickel and brass). Activation covers shall be available in flanged and flangeless versions. Covers shall be available with options for tile or carpet inserts, or flush covers. The cover’s hinge shall allow for the cover to open 180 degrees. The furniture feed covers shall come equipped with one (1) 1-inch trade size screw plug opening and one (1) combination 11/4-inch and 2-inch trade size screw plug.

1. Flanged covers shall be 7-3/4" L x 6-9/16" W [197mm x 167mm].
2. Flangeless covers shall be 6-3/4" L x 5-9/16" W [171mm x 142mm].

B. 8CT Series Covers: Manufactured of die-cast aluminum alloy and available in powder-coated gray, black, brass, nickel or bronze finish. The covers shall be available in carpet and tile versions. Provide covers with two (2) gaskets (one (1) for carpet and one (1) for tile) to go under the trim flange to maintain scrub water tightness. The activation cover shall be 9-1/4-inch [235mm] in diameter. The carpet covers shall be surface mounted and the tile covers shall be flush with the finished floor covering. The cover shall have spring loaded slides to allow cables to egress out of the unit and maintain as small an egress opening as possible.

C. The covers shall have been evaluated by UL to meet the applicable U.S. and Canadian safety standards for scrub water exclusion when used on tile, terrazzo, wood, and carpet covered floors.

2.4 COMMUNICATION MODULES MOUNTING ACCESSORIES

A. The floor box manufacturer shall provide a complete line of faceplates and bezels to facilitate the mounting of UTP, STP (150 ohm), fiber optic, coaxial, and communication devices. The box shall provide a series of device mounting plates that will accommodate Ortronics workstation connectivity outlets and modular adapters, the Pass and Seymour Network Wiring System, and other open system devices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions under which boxes and fittings are to be installed and substrate that will support boxes. Notify the [Architect/Engineer] [Construction Manager] in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Strictly comply with manufacturer's installation instructions and recommendations and approved shop drawings. Coordinate installation with adjacent work to ensure proper clearances and to prevent electrical hazards.

B. Mechanical Security: Raceway systems shall be mechanically continuous and connected to all electrical outlets, boxes, device mounting brackets, and cabinets, in accordance with manufacturer’s installation sheets.

C. Accessories: Provide accessories as required for a complete installation, including insulated bushings and inserts where required by manufacturer.

D. Unused Openings: Close unused box openings using manufacturer's recommended accessories.

E. Provide a minimum concrete pour depth of 3-7/16-inch [87mm] plus 1/16-inch above the top of the box for the RFB4, RFB4-4DB, RFB2, and the RFB2-OG Series Boxes; 2-7/16-inch plus 1/16-inch for the RFB4-SS and RFB2-SS Series Boxes; and 3-7/16-inch plus 13/16-inch above the top of the box for the RFB4-CI-1, RFB6, RFB6-OG, RFB6E and RFB6E-OG Boxes. Provide the box with four (4) locations to accommodate leveling for pre-concrete pour adjustment and include four (4) leveling screws for the pre-pour adjustment.

3.3 CLEANING AND PROTECTION

A. Clean exposed surfaces using non-abrasive materials and methods recommended by manufacturer.

B. Protect boxes and fittings until acceptance.

END OF SECTION 260533

SECTION 26 05 43 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks, and in single duct runs.
2. Handholes and boxes.
3. Manholes.

1.3 DEFINITION

A. RNC: Rigid nonmetallic conduit.

B. HDPE: High Density Polypropylene

1.4 SUBMITTALS

A. Product Data: For the following:

1. Duct-bank materials, including separators and miscellaneous components.
2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Accessories for manholes, handholes, boxes, and other utility structures.
4. Warning tape.
5. Warning planks.

B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Reinforcement details.
3. Frame and cover design and manhole frame support rings.
4. Ladder details.
5. Grounding details.
6. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
7. Joint details.

C. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:

1. Duct entry provisions, including locations and duct sizes.

2. Cover design.
3. Grounding details.
4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

D. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
2. Drawings shall be signed and sealed by a qualified professional engineer.

E. Product Certificates: For concrete and steel used in precast concrete [manholes] [and] [handholes], as required by ASTM C 858.

F. Qualification Data: For professional engineer and testing agency.

G. Source quality-control test reports.

H. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Comply with ANSI C2.

C. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Construction Manager's written permission.

1.8 COORDINATION

A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Furnish cable-support stanchions, arms, and associated fasteners in quantities equal to 5 percent of quantity of each item installed.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NON-METALLIC HDPE CONDUIT

A. Solid Wall High Density polyethylene (HDPE) conduit is based on ASTM F 2160 and shall be used primarily for underground applications as conduit, innerduct, direct buried or concrete encased applications. The HDPE shall meet or exceed the properties listed in ASTM D-3350 for minimum cell classification of 335480 C or E (color with UV stabilizer).

1. Conduit shall be UL labeled and confirm to NEC 353 and be manufactured in accordance with UL 651A.
2. *Conduit shall be SDR-11 in non-traffic areas and Schedule 40 in areas below traffic.*
3. *Lubrication shall be allowed for interior to reduce friction. Consult manufacturer for allowable types.*
4. *Use pull-strings where shown or required on the plans.*
5. *Acceptable HDPE manufacturers:*

Dura-line
Carlon
Others by approval

2.3 NONMETALLIC DUCTS AND DUCT ACCESSORIES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. ARNCO Corp.
2. Beck Manufacturing.
3. Cantex, Inc.
4. CertainTeed Corp.; Pipe & Plastics Group.
5. Condux International, Inc.
6. ElecSys, Inc.
7. Electri-Flex Company.
8. IPEX Inc.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT; a division of Cable Design Technologies.
11. Spiraduct/AFC Cable Systems, Inc.

D. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type EB-20-PVC, ASTM F 512, UL 651A, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.

E. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type DB-60-PVC, ASTM F 512, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.

F. Duct Accessories:

1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
2. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."
3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches in size, manufactured from 6000-psi concrete.

a. Color: Red dye added to concrete during batching.
b. Mark each plank with "ELECTRIC" in 2-inch-high, 3/8-inch-deep letters.

2.4 PRECAST CONCRETE HANDHOLES AND BOXES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carder Concrete Products.
2. Christy Concrete Products.
3. Elmhurst-Chicago Stone Co.
4. Oldcastle Precast Group.
5. Riverton Concrete Products; a division of Cretex Companies, Inc.
6. Utility Concrete Products, LLC.
7. Utility Vault Co.

8. Wausau Tile, Inc.

C. Comply with ASTM C 858 for design and manufacturing processes.

D. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
2. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
3. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
    a. Cover Hinges: Concealed, with hold-open ratchet assembly.
    b. Cover Handle: Recessed.
4. Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
    a. Cover Hinges: Concealed, with hold-open ratchet assembly.
    b. Cover Handle: Recessed.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering "ELECTRIC." And "TELEPHONE." Or as indicated for each service.
7. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
8. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
    a. Extension shall provide increased depth of 12 inches.
    b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
9. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
    a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
    b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
    c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

10. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
    a. Type and size shall match fittings to duct or conduit to be terminated.
    b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
11. Handholes [12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.5 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Description: Comply with SCTE 77.
   1. Color: Gray
   2. Configuration: Units shall be designed for flush burial and have [open] [closed] [integral closed] bottom, unless otherwise indicated.
   3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
   4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   5. Cover Legend: Molded lettering, "ELECTRIC." OR "TELEPHONE" or as indicated for each service.
   6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
   7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
   8. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. Basis-of-Design Product: Subject to compliance with requirements, provide [the product indicated on Drawings] or a comparable product by one of the following:
      a. Armorcast Products Company.
      b. Carson Industries LLC.
      c. CDR Systems Corporation.
      d. NewBasis.
      e. <Insert manufacturer's name.>

C. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide [the product indicated on Drawings] or a comparable product by one of the following:

    a. Armorcast Products Company.
    b. Carson Industries LLC.
    c. Christy Concrete Products.
    d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

D. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of polymer concrete

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:

    a. Carson Industries LLC.
    b. Christy Concrete Products.
    c. Nordic Fiberglass, Inc.

E. High-Density Plastic Boxes: Injection molded of high-density polyethylene or copolymer-polypropylene. Cover shall be polymer concrete.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide [the product indicated on Drawings] or a comparable product by one of the following:

    a. Carson Industries LLC.
    b. Nordic Fiberglass, Inc.
    c. PenCell Plastics.

2.6 PRECAST MANHOLES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carder Concrete Products.
2. Christy Concrete Products.

3. Elmhurst-Chicago Stone Co.
4. Oldcastle Precast Group.
5. Riverton Concrete Products; a division of Cretex Companies, Inc.
6. Utility Concrete Products, LLC.
7. Utility Vault Co.
8. Wausau Tile, Inc.

C. Comply with ASTM C 858[, with structural design loading as specified in Part 3 "Underground Enclosure Application" Article] and with interlocking mating sections, complete with accessories, hardware, and features.

1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

    a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
    b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
    c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

2. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
    a. Type and size shall match fittings to duct or conduit to be terminated.
    b. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.

D. Concrete Knockout Panels: 1-1/2 to 2 inches thick, for future conduit entrance and sleeve for ground rod.

E. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.7 CAST-IN-PLACE MANHOLES

A. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for conduit entrance and sleeve for ground rod.

B. Materials: Comply with ASTM C 858 and with Division 03 Section "Cast-in-Place Concrete."

C. Structural Design Loading: As specified in Part 3 "Underground Enclosure Application" Article.

2.8 UTILITY STRUCTURE ACCESSORIES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bilco Company (The).
2. Campbell Foundry Company.
3. Carder Concrete Products.
4. Christy Concrete Products.
5. East Jordan Iron Works, Inc.
6. Elmhurst-Chicago Stone Co.
7. McKinley Iron Works, Inc.
8. Neenah Foundry Company.
9. NewBasis.
10. Oldcastle Precast Group.
11. Osburn Associates, Inc.
12. Pennsylvania Insert Corporation.
13. Riverton Concrete Products; a division of Cretex Companies, Inc..
14. Strongwell Corporation; Lenoir City Division.
15. Underground Devices, Inc.
16. Utility Concrete Products, LLC.
17. Utility Vault Co.
18. Wausau Tile, Inc.

C. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.

1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B] with milled cover-to-frame bearing surfaces; diameter, 26 inches.

a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.

2. Cover Legend: Cast in. Selected to suit system.
    a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
    b. Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.
    c. Legend: "SIGNAL" for communications, data, and telephone duct systems.
3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
    a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C 387, Type M, may be used.

D. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.

E. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch-diameter eye, and 1-by-4-inch bolt.
1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.

F. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch-diameter eye, rated 2500-lbf minimum tension.

G. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch-diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.

H. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.
1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.

I. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.

J. Cable Rack Assembly: Steel, hot-rolled, galvanized, except insulators.
1. Stanchions: T-section or channel; 2-1/4-inch nominal size; punched with 14 holes on 1-1/2-inch centers for cable-arm attachment.
2. Arms: 1-1/2 inches wide, lengths ranging from 3 inches with 450-lb minimum capacity to 18 inches with 250-lb minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.

K. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.

1. Stanchions: Nominal 36 inches high by 4 inches wide, with minimum of 9 holes for arm attachment.
2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches with 450-lb minimum capacity to 20 inches with 250-lb minimum capacity. Top of arm shall be nominally 4 inches wide, and arm shall have slots along full length for cable ties.

L. Duct-Sealing Compound: Non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

M. Fixed Manhole Ladders: Arranged for attachment to wall of manhole. Ladder and mounting brackets and braces shall be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin

N. Cover Hooks: Heavy duty, designed for lifts 60 lbf and greater. Two required.

2.9 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by a independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION (OUTSIDE THE BUILDING)

A. Service Entrance Ducts for Electrical Cables Over 600 V: RNC, NEMA Type [EPC-80] [EB-20]-PVC, in concrete-encased duct bank, unless otherwise indicated.

B. Secondary Service Entrance Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type [EPC-80] [EB-20]-PVC, in concrete-encased duct bank, unless otherwise indicated.

C. Ducts for Electrical Feeders 600 V and Less: HDPE, in direct-buried duct bank, unless otherwise indicated.

D. Ducts for Electrical Branch Circuits: HDPE, in direct-buried duct bank, unless otherwise indicated.

E. Service Entrance Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.

F. .Branch Underground Ducts for Telephone, Communications, or Data Utility Service Cables: HDPE direct buried.

3.2 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Non-deliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.
3. Units in Sidewalk and Similar Applications with a Safety Factor for Non-deliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 structural load rating.
4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin structurally tested according to SCTE 77 with 3000-lbf vertical loading.

B. Manholes: Precast concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.3 EARTHWORK

A. Excavation and Backfill: Comply with Division 31 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turf and Grasses" and "Plants."

D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

3.4 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations, unless otherwise indicated.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
3. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet (3 m) outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical."

F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

G. Pulling Cord: Install 100-lbf-test nylon cord in ducts, including spares.

H. Concrete-Encased Ducts: Support ducts on duct separators.

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
    a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
    b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (19-mm) reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.
3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank

and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
6. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches (100 mm) between power and signal ducts.
7. Depth: Install top of duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
8. Stub-Ups: Use manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Extend concrete encasement throughout the length of the elbow.
9. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
10. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

I. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than [4] [5] spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches (150 mm) between tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section "Earth Moving" for pipes less than 6 inches (150 mm) in nominal diameter.
4. Install backfill as specified in Division 31 Section "Earth Moving."
5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over

final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."

6. Install ducts with a minimum of 3 inches between ducts for like services and 6 inches between power and signal ducts.
7. Depth: Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated.
8. Set elevation of bottom of duct bank below the frost line.
9. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
10. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
11. Warning Planks: Bury warning planks approximately 12 inches above direct-buried ducts and duct banks, placing them 24 inches o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18 inches (450 mm). Space additional planks 12 inches apart, horizontally.

3.5 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Cast-in-Place Manhole Installation:

1. Finish interior surfaces with a smooth-troweled finish.
2. Windows for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches thick, arranged as indicated.
3. Cast-in-place concrete, formwork, and reinforcement are specified in Division 03 Section "Cast-in-Place Concrete."

B. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891, unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches (380 mm) below finished grade.
2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
3. Install handholes with bottom below the frost line, <Insert depth of frost line below grade at Project site> below grade.

4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
5. Where indicated, cast handhole cover frame integrally with handhole structure.

D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

E. Manhole Access: Circular opening in manhole roof; sized to match cover size.

1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

F. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Division 07 Section "[Elastomeric Sheet Waterproofing] [Thermoplastic Sheet Waterproofing]." After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.

G. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Division 07 Section "Bituminous Dampproofing." After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.

H. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, [and insulators, as required for installation and support of cables and conductors and as indicated.

I. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

J. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

K. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.6 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install handholes and boxes with bottom below the frost line, 36” below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. For enclosures installed in asphalt paving and subject to occasional, non-deliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth

1. Concrete: 4000 psi, 28-day strength, complying with Division 03 Section "Cast-in-Place Concrete," with a troweled finish.
2. Dimensions: 10 inches wide by 12 inches deep.

3.7 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.9 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 260543

SECTION 26 05 53 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.2 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system service type.

C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pre-tensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pre-tensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

F. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.2 METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Colors for Raceways Carrying Circuits at 600 V and Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

D. Snap-Around Labels: Slit, pre-tensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Snap-Around, Color-Coding Bands: Slit, pre-tensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

D. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.5 FLOOR MARKING TAPE

A. 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.6 WARNING LABELS AND SIGNS

A. Comply with NFPA 70.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 0.25-inch grommets in corners for mounting.
3. Nominal size, 7 by 10 inches.

D. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.7 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 0.625-inch thick for signs up to 20 sq. inches and 0.125-inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 0.375-inch.

C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 0.375-inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.8 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 0.375-inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

B. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 0.375-inch.

C. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Apply identification devices to surfaces that require finish after completing finish work.

C. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

D. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

E. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

F. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

G. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Install labels at 30-foot maximum intervals.

B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Emergency Power.
2. Power.

C. Junction Boxes: All junction boxes containing emergency feeder branch circuits shall be painted with colors indicated below. ALL sides of the junction box shall be painted to allow easy identification, including cover.

1. Orange – Critical Branch

2. Red Stripe – Life Safety Branch
3. Yellow – Equipment Branch

D. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.

a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
b. Colors for 208/120-V Circuits:

1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.

c. Colors for 480/277-V Circuits:

1) Phase A: Brown.
2) Phase B: Orange.
3) Phase C: Yellow.

d. Control/Instrumentation Wire:

1) 120VAC control signal: Red
2) 120VAC line power: Black
3) 120VAC line neutral: White
4) Grounds: Green
5) DC ungrounded Control Circuits: Blue
6) DC grounded Control Circuits: White with Blue stripe
7) Analog Pair: Black/White or Black/Red
8) Instrument signal Cable Jacket: Black or Gray
9) RTD V+ (device): Black
10) RTD V- (device): White
11) RTD compensation (device): Red
12) Externally powered: Orange
13) Intrinsically Safe: Light Blue

e. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

E. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

G. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

H. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:

a. Power transfer switches.
b. Controls with external control power connections.

I. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction

signs with approved legend where instructions are needed for system or equipment operation.

J. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

TYPE 1: Laminated phenolic plastic with black Gothic-condensed lettering by Seaton or Wilco.

TYPE 2: Self-sticking 0.5-inch wide flexible nylon tape with high gloss surface and typed smearproof, chemical/solvent resistant lettering by Brady or Dymo.

TYPE 3: Self-sticking polyester sign with wording and size conforming to ANSI Standard Z35.1 - 1964 and OSHA 19.0.144iii(2) Specifications, by Brady or as approved.

TYPE 4: Self-sticking flexible vinyl with oil resistant adhesive for -20 degrees to 300 degrees F. temperatures by Brady or as approved.

a. Provide switchboards with Type 1 signs 2.5 inches x 12 inches indicating switchboards designation and electrical characteristics as noted on drawings. Provide switchboards sections operating at different voltages with Type I sign 2 inches by 8 inches indicating electrical characteristics of section. Provide each switchboard device with Type 1 sign 1.25 inches by 5 inches indicating load served.
b. Provide distribution panelboards with Type 1 signs 2 inches by 8 inches indicating panel designation and electrical characteristics. Provide branch devices with Type 1 sign 1 inch by 4 inches indicating load served.
c. Provide lighting and power panelboards with Type 1 sign 1.25 inches by 6 inches indicating panel designation, electrical characteristics, and source of power. Source of power indication shall indicate source panel designation and switch or breaker number. Mount inside of panel door on circuit breaker trim flange just below breakers.
d. Provide disconnect switches, time switches, lighting contactors, motor starters and controllers with Type 1 sign 1.25 inches by 6 inches indicating equipment served, electrical characteristics, and source of power,
e. Provide feeders and branch circuit home runs with Type 4 wire marker indicating circuit number and power source. Provide feeders phase identification letter at each terminal point in addition to its circuit number.
f. Provide Type 2 tape at feeder terminal lugs to switchboards and panelboards. Tape shall indicate conduit size, conductor type and AWG size. Tape shall be located to be easily read with conductors installed.

K. Panelboard Labeling:

1. Contractor shall provide new circuit directories at all panelboards in which a load alteration has occurred. Labels shall be typed, posted to the inside of the panelboard door and indicate all new and existing loads. Existing loads that have been removed shall be labeled as “spare”. Existing loads that have been altered (reused or added) shall be indicate the (new) load served on the directory.

END OF SECTION 260553

SECTION 26 05 55 – SERVICE ENTRANCE

PART 1 - GENERAL

NOT USED

PART 2 - PRODUCTS

Proper Identification and Labels for such UL ratings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation of Service Entrance Equipment

1. Install service entrance equipment as indicated, in accordance with manufacturer's written instructions, and with recognized industry practices; complying with applicable requirements of NEC, NEMA's Stds Pub/No. 2.1, and NECA's "Standard of Installation".
2. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std. 486A and B, and the National Electrical Code.

3.2 FIELD QUALITY CONTROL

A. Prior to energization of circuitry, check all accessible connections to manufacturer's torque tightening specifications.

B. Prior to energization of switchboards, check with ground resistance tester phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.

C. Prior to energization, check equipment for electrical continuity of circuits, and for short-circuits.

D. Ground fault testing: The ground fault system shall have an operational and performance test performed. Testing shall be performed by an organization with a minimum of 10 years' experience in performing such tests and is recognized and approved by the local authority having jurisdiction. The testing shall be performed in accordance with the equipment manufacturer's instructions and requirements listed below. A report shall be submitted to the Owner with the following minimum information:

1. Name, address and telephone number of testing agency.

2. Name of person responsible for testing (corporate officer and/or registered electrical engineer).
3. Project address where system is installed.
4. General description of ground fault system including manufacturer's name address, telephone number, and contact person. Include a one line sketch of major system components.
5. Manufacturer's model and serial number, including electrical rating, accessories installed, and all adjustable parameter setting ranges.
6. Verification that equipment is UL listed.

E. Documented results of the following tests and inspections:

1. Verify installation and operation per Article 230-95 of the National Electrical Code, NFPA 70.
2. Visually inspect for the following:
    a. Physical damage and compliance with the plans and specifications.
    b. Neutral main bonding jumper to assure zero sequence sensing system is grounded, grounded conductor (neutral) is solidly grounded, grounded connection is made ahead of neutral disconnect link and ground strap sensing systems are grounded through the sensing device.
    c. Ground fault device circuit nameplate identification matches the piece of equipment.
3. Manually operate and verify the following:
    a. Pickup and time delay settings match manufacturer recommended settings. Adjust to match provided settings if discrepancies are found.
4. Perform the following electrical tests:
    a. Neutral insulation resistance to ensure no shunt ground path exists. Remove neutral disconnect link and replace after test. Neutral insulation shall be a minimum of 100 megohms.
    b. Determine the relay pickup current by secondary injection using manufacturers standard test kit to operate the circuit interrupting device. Relay pickup shall be within ten percent (10%) of device dial or fixed setting and under no circumstances greater than 1200 amperes.
    c. Determine relay timing by secondary injection, using manufacturers standard test kit, of 150% and 300% of pickup current or as specified by the manufacturer. Relay timing shall be in accordance with manufacturer's published time-current characteristic curves but in no case longer than one second for fault current equal to or greater than 3000 amperes.
    d. System operation at 57% of rated voltage.
    e. Where the ground fault system performance does not meet the specified test parameters, make adjustments and/or replace defective components as required and retest until parameters are met.
5. Conclude the report with the following statement: "The service entrance section and associated electric distribution equipment installed at the project site addressed by this report have a functioning ground fault protection system which satisfies the requirements of Article 230-95 of the National Electrical Code, NFPA 70. In my opinion, the installation is currently in a safe operational condition."
6. SPD manufacturer's representative shall visit site, verify SPD protected panelboard installation, and submit to Owner or Owners representative a letter stating equipment and installation meets intent of Contract documents, and manufacturer's warranties and guarantees are in effect.
    a. Adjusting and Cleaning
        1) Adjust operating mechanisms for free mechanical movement.
        2) Touch-up scratched or marred surfaces to match original finishes.

3) Clean all dust and debris from equipment prior to energizing. During construction take necessary precautions to prevent dirt from accumulating in equipment. Return equipment to a state as delivered from manufacture including lubrication of connections

b. Grounding
   1) Provide equipment grounding connections for switchboards as indicated. Tighten connections to comply with tightening torques specified in UL Std. 486A to assure permanent and effective grounds.

c. Demonstration

1) Subsequent to wire and cable hook-ups, energize switchboards and test functioning for compliance with requirements. Where necessary, correct malfunctioning units, and then retest for compliance.

END OF SECTION 260555

SECTION 26 05 73 - ARC FLASH HAZARD ANALYSIS/SHORT CIRCUIT/COORDINATION STUDY

PART 1 - GENERAL

1.1 SCOPE

A. The owner shall be furnished short-circuit and protective device coordination studies as prepared by the contractor/gear vendor.

B. Contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in the current issue of the NFPA 70E – Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE Standard 1584 – 2002, the IEEE Guide for Performing Arc-Flash Calculations.

C. The scope of the studies shall include the electrical distribution equipment as identified by the Owner.

1.2 RELATED SECTIONS

A. Drawings and general provisions of the Contract.

1.3 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems.
2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis.
4. IEEE 241 – Recommended practice for Electric Power Systems in Commercial Buildings.
5. IEEE 1015 – Recommended practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
6. IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations.

B. American National Standards Institute (ANSI):

1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
2. ANSI C37.13 – Standard Low Voltage AC Power Circuit Breakers Used in Enclosures.
3. ANSI C37.010 – Standard Application Guide for AC High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Connecting Switches and Accessories.

C. The National Fire Protection Association (NFPA):

1. NFPA 70 – National Electrical Code, latest edition.
2. NFPA 70E – Standard for Electrical Safety in the Workplace.

1.4 SUBMITTALS FOR REVIEW/APPROVAL

A. A preliminary Arc Flash Hazard Analysis shall be submitted to the Owner's Representative no later than six (6) weeks after the overcurrent protective device shop drawings have been approved.

B. The studies shall be submitted to the Engineer/Owner for a review and approval prior to final completion of electrical gear shop drawings or simultaneously.

1.5 FINAL SUBMITTALS

A. The results of the short-circuit protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. A minimum of five (5) bound copies of the complete final report shall be submitted. For large system studies, submittal requiring more than five (5) copies of the report will be provided without the section containing the computer printout of the short-circuit input and output data. Electronic PDF copies of the report shall be provided upon request. A CD containing all study files, including all device curves shall be provided (use the SKM "Project-Backup" command).

B. The report shall include the following sections:

1. Executive Summary including Introduction, Scope of Work, and Results/Recommendations.
2. Short-Circuit methodology Analysis Results and Recommendations.
3. Short-Circuit Device Evaluation Table.
4. Protective Device Coordination Methodology Analysis Results and Recommendations.
5. Protective Device Settings Table.
6. Time-Current Coordination Graphs and Recommendations.
7. Arc Flash Hazard Methodology Analysis Results and Recommendations including the details of the incident energy and flash protection boundary calculations, along with the Arc Flash boundary distances, working distances, Incident Energy levels and Personal Protection Equipment levels.
8. Arc Flash Labeling section showing types of labels provided. Section will contain descriptive information as well as typical label images.
9. One-line system diagram that shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short-circuit current at each bus location, device numbers used in the time-current coordination analysis, and other information pertinent to the computer analysis.

1.6 QUALIFICATIONS

A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the responsible charge and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.

B. The registered Professional Electrical Engineer shall be an employee of the approved engineering firm.

C. The registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies.

D. The approved engineering firm shall demonstrate experience with Arc Flash Analysis by submitting names of at least ten actual arc flash analyses it has performed in the past year.

E. The engineering firm shall have a minimum of twenty-five (25) years' experience in performing power system studies.

F. The study shall include the stamp or seal and signature of the preparing engineer and shall be reviewed and approved by the Engineer of Record.

1.7 COMPUTER ANALYSIS SOFTWARE

A. The studies shall be performed using SKM Systems Analysis Power Tools for Windows (PTW 32) software program.

PART 2 - PRODUCTS

2.1 STUDIES

A. Contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E – Standard for Electrical Safety in the Workplace, preference Article 130.3 and Annex D. This study shall also include Short-circuit and protective device coordination studies.

2.2 DATA COLLECTION

A. Field data collection shall be performed by a qualified (as defined by the NFPA 70E – 2004) technician to ensure accurate equipment modeling. The technician shall have completed an 8-hour instructor-led Electrical Safety Training Course. The course shall include NFPA 70E training which includes the selection and use of personal protective equipment.

B. Contractor will visually inspect to verify the equipment readings, conductor ratings and overcurrent device data by removing panels, covers, and doors where required to document the necessary data used in the analysis. Contractor can perform these inspections with the equipment energized provided the incident energy values are less than 40cal/cm², greater values or unusual site conditions will require an equipment shutdown so the equipment can be inspected and de-energized.

C. The Owner shall provide qualified personnel to show the Contractor technician the equipment location and to open all equipment doors, locks, etc. necessary to collect nameplate data.

D. Contractor will verify the owner's one-line drawings and provide marked corrections where discrepancies are found.

1. Data collection shall begin downstream from the utility service and continue down through the Owner's electrical distribution system as defined under the scope of work. The study shall not include any single phase AC circuits or DC distribution systems as these types of circuits and systems are excluded from IEEE 1584-2002 Arc Flash calculation guidelines.

E. Contractor shall obtain from Owner the minimum, normal, and maximum operating service voltage levels, three-phase short circuit MVA and X/R ratio, as well as line-to-ground short-circuit MVA and X/R ratio at the point of connection as show on the drawings.

2.3 SHORT-CIRCUIT ANALYSIS

A. Transformer design impedances shall be used when test impedances are not available.

B. Provide the following:

1. Calculation methods and assumptions.
2. Selected base per unit quantities.
3. One-line diagram of the system being evaluated that clearly identifies individual equipment buses, bus numbers used in the short-circuit analysis, cable and buss connections between the equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the computer analysis.
4. The study shall include input circuit data including electrical utility system characteristics, source impedance data, conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances, and X/R ratios, motor contributions, and other circuit information as related to the short-circuit calculations.
5. Tabulations of calculated quantities including short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings and notes regarding adequacy or inadequacy of the equipment rating.
6. Results, conclusions, and recommendations. A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for improvements to the system.
7. For solidly-grounded systems, provide a bolted line-to-ground fault current study for applicable buses as determined by the engineer performing the study.

C. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare short circuit ratings.
2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses.
3. Contractor shall notify Owner in writing, of any circuit protective devices improperly rated for the calculated available fault current.

2.4 PROTECTIVE DEVICE TIME-CURRENT COORDINATION ANALYSIS

A. Protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.

B. Include on each TCC graph, a complete title with descriptive device names.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the TCC graphs, where applicable:

1. Electric utility's overcurrent protective device
2. Medium voltage equipment overcurrent relays
3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
4. Low voltage equipment circuit breakers trip devices, including manufacturer's tolerance bands
5. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves
6. Medium voltage conductor damage curves
7. Ground fault protective devices, as applicable
8. Pertinent motor starting characteristics and motor damage points, where applicable
9. Pertinent generator short-circuit decrement curve and generator damage point
10. The largest feeder circuit breaker in each motor control center and applicable panel board.

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

G. Provide the following:

1. A One-line diagram shall be provided which clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus when known.
2. A sufficient number of log-log plots shall be provided to indicate the degree system protection and coordination
3. Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices shown, settings of the adjustable devices, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagrams.
4. The study shall include a separate, tabular printout containing the recommended settings of all adjustable overcurrent protective devices, the equipment designation

where the device is located, and the device number corresponding to the device on the system one-line diagram.

5. A discussion session which evaluates the degree of system protection and service continually with overcurrent devices, along with recommendations as required for addressing system protection or device coordination deficiencies.
6. Contractor shall notify Owner in writing of any significant deficiencies in protection and/or coordination. Provide recommendations for improvements.

2.5 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA17E-2009, Annex D. The arc flash hazard analysis shall be performed in conjunction with the short-circuit analysis (Section 2.03) and the protective device time-current coordination analysis (Section 2.04).

B. The flash protection boundary and the incident energy shall be calculated at significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panel boards, busway and splitters) where work could be performed on energized parts.

C. The analysis shall be based on the specific devices installed and include (but not limited to) the following:

1. Service Entrance Equipment
    a. All overcurrent protective devices installed in service entrance panels.
2. Feeder Circuits
    a. All three (3) phase Feeder circuit overcurrent protective devices installed with a rating equal to or greater than 30 amps.
3. Branch Circuits
    a. All three (3) phase Feeder circuit overcurrent protective devices installed with a rating equal to or greater than 30 amps.
    b. All motor circuit overcurrent protective devices for motors with a rating equal to or greater than 10 horse power.
4. Equipment
    a. All three (3) phase safety disconnects or combination motor starter disconnect switches for equipment fed from a circuit breaker with a rating equal to or greater than 30 amps.
5. Motor Control Centers
    a. All motor circuit overcurrent protective devices for motors with a rating equal to or greater than 10 horse power.

D. Working distances shall be based on IEEE 1584. The calculated arc flash protective boundary shall be determined using those working distances.

E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model.

Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location in a single table. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum. Conversely, the maximum calculation will assume a maximum contribution from the utility. Calculations shall take consideration the parallel operation of synchronous generators with the electric utility, where applicable as well as any stand-by generator applications.

1. The Arc Flash Hazard Analysis shall be performed utilizing mutually agreed upon facility operational conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.

G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors should be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond 5 cycles.

H. For each piece of an ANSI rated equipment with an enclosed main device, two calculations shall be made. A calculation shall be made for the main cubicle, sides, or rear; and shall be based on a device located upstream of the equipment to clear the arcing fault. A second calculation shall be made for the front cubicles and shall be based on the equipment's main device to clear the arcing fault. For all other non-ANSI rated equipment, only one calculation shall be required and it shall be based on a device located upstream of the equipment to clear the arcing fault.

I. When performing incident energy calculations on the lone side of a main breaker (as required per above), the line side and load contributions must be included in the fault calculation.

J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. A maximum clearing time of 2 seconds will be used based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

L. Provide the following:

1. Results of the Arc-Flash Hazard Analysis shall be submitted in tabular form, and shall include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, working distances, personal-protection equipment classes and AFIE (Arc Flash Incident Energy) levels.
2. The Arc-Flash Hazard Analysis shall report incident energy values based on recommended device settings for equipment within the scope of the study.
3. The Arc-Flash Hazard Analysis may include recommendations to reduce AFIE levels and enhance worker safety.

PART 3 - EXECUTION

3.1 FIELD ADJUSTMENT

A. The contractor shall adjust relay and protection device settings according to the recommended settings table provided by the coordination study.

B. The contractor shall make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. The Arc Flash Hazard Analysis shall be reviewed and updated to reflect any changes and corrections to conductor length within one week of the final electrical walk through for punchlist.

3.2 ARC FLASH LABELS

A. Contractor shall provide a 4.0 in. x 4.0 in. thermal transfer type label or high adhesive polyester for each work location analyzed.

B. The labels shall be designed according to the following standards:

1. UL969 – Standard for Marking and Labeling Systems
2. ANSI Z535.4 – Product Safety Signs and Labels
3. NFPA 70 (National Electric Code)- Article 111.16

C. The label shall include the following information:

1. System Voltage
    a. Flash protection boundary
    b. Personal Protective Equipment category
    c. Arc Flash Incident energy value (cal/cm²)
    d. Limited, restricted, and prohibited Approach Boundaries
        1) Study report number and issue date

D. Labels shall be printed by a thermal transfer type printer, with no field markings.

E. Arc flash labels shall be provided for equipment as identified in the study and the respective equipment access areas per the following:

1. Floor Standing Equipment – Labels shall be provided on the front of each individual section. Equipment requiring rear and/or side access shall have labels provided

on each individual section access area. Equipment line-ups containing sections with multiple incident energy and flash protection boundaries shall be labeled as identified in the Arc Flash Analysis table.

2. Wall Mounted Equipment – Labels shall be provided on the front cover or a nearby adjacent surface, depending upon equipment configuration.

    a. General Use Safety labels shall be installed on equipment in coordination with the Arc Flash labels. The General Use Safety labels shall warn of general electrical hazards associated with shock, arc flash, and explosions, and instruct workers to turn off power prior to work.

F. Owner approved Arc Flash Hazard warning tables shall be furnished and installed prior to project completion.

END OF SECTION 260573

SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following lighting control devices:

1. Time switches.
2. Outdoor photoelectric switches.
3. Indoor occupancy sensors.
4. Outdoor motion sensors.
5. Lighting contactors.
6. Emergency shunt relay.

B. See Division 26 Section "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Field quality-control test reports.

C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Intermatic, Inc.
2. Leviton Mfg. Company Inc.
3. Lithonia Lighting; Acuity Lighting Group, Inc.
4. Paragon Electric Co.; Invensys Climate Controls.
5. Square D; Schneider Electric.
6. TORK.
7. Watt Stopper (The).

B. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.

1. Contact Configuration: DPST.
2. Contact Rating: 20-A ballast load, 120/240-V ac.

3. Program: 8 on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays.
4. Program: 2 on-off set points on a 24-hour schedule, allowing different set points for each day of the week and an annual holiday schedule that overrides the weekly operation on holidays.
5. Programs: 6 channels; each channel shall be individually programmable with 8 on-off set points on a 24-hour schedule.
6. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
7. Battery Backup: For schedules and time clock.

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 0.5-inch.

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.2 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
2. Operational Test: Verify operation of each lighting control device, and adjust time delays.

B. Lighting control devices that fail tests and inspections are defective work.

END OF SECTION 260923

SECTION 26 09 43 - NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

1.01. SUMMARY

A. The Contractor shall coordinate all of the work in this section with all of the trades covered in other sections of the specification to provide a complete and operable system. The extent of the lighting control system work is indicated by the drawings and by the requirements of this section. It is defined to include, but not by way of limitation:

B. The entire building shall be provided with a distributed type lighting control system.

C. The lighting control system shall provide time-based, sensor-based (both occupancy and daylight), and manual lighting control. The system shall be capable of turning lighting loads on/off as well as dimming lights (if lighting load is capable of being dimmed) All system devices shall be networked together enabling digital communication and shall be individually addressable. The system architecture shall be capable of enabling stand-alone groups (rooms) of devices to function in some default capacity even if network connectivity to the greater system is lost. The system architecture shall facilitate remote operation via a computer connection. The system shall not require any centrally hardwired switching equipment.

D. System shall have an architecture that is based upon three main concepts; 1) intelligent lighting control devices 2) standalone lighting control zones 3) network backbone for remote or time-based operation.

E. Intelligent lighting control devices shall consist of one or more basic lighting control components; occupancy sensors, photocell sensors, relays, dimming outputs, manual switch stations, and manual dimming stations. Combining one or more of these components into a single device enclosure should be permissible so as to minimize overall device count of system.

F. System must interface directly with intelligent LED luminaires such that only CAT-5 cabling is required to interconnect luminaires with control components such as sensors and switches (see section

1. System installation includes the following:

    a. Wiring of main and branch circuit conductors
    b. Installation of external control devices and wiring to the panelboard controller.
    c. Installation of communications conductors and associated hardware

1.02. QUALITY ASSURANCE

A. Manufacturers: Firms engaged in the manufacture of lighting control equipment and ancillary equipment, of the types indicated, whose products have been in satisfactory use in similar service for not less than five years.

B. Manufacture quality system: Registered to ISO 9001: 2000 Quality Standard.

C. Component Testing: All electronic component board assemblies are to be factory tested and burned in prior to installation.

D. System Support: Factory fax/telephone/email support shall be available free of charge during normal business hours.

1.03. REFERENCES

A. NEMA Compliance: Applicable portions of NEMA standards pertaining to types of electrical equipment and enclosures.

B. NEC Compliance: Applicable portions of the NEC including Articles 110-10.

C. UL Compliance: Applicable UL standards for panelboards, circuit breakers and energy management equipment.

D. FCC Emissions: Compliance with FCC emissions Standards specified in Part 15, Subpart J for Class A applications

E. California Title 24: All lighting control equipment shall be certified by the California Energy Commission.

F. Seismic compliance: NFPA 5000, ASCE7, ICC ES AC156

1.04. WARRANTY

A. Manufacturer shall warrant specified equipment to be free from defects in materials and workmanship for at least one year from the date of installation or eighteen months from date of purchase.

1.05. MANUFACTURES

A. Acceptable manufacturer: Wattstopper DLM, N-Light, Lutron, or other approved equal.

B. Substitutions

1. All substitutions (clearly identified as such) must be submitted in writing for approval by the design professional at least 7 working days prior to bid date. Substitutions must be available to all bidders.
2. Proposed substitutions must include detailed summary of specification review noting compliance on line basis.
3. Contractor accepts responsibility and associated costs for all required modifications to circuitry, devices, and structural changes
4. Complete shop drawings with deviations are required for review prior to installation and rough-in.

1.06. SUBMITTALS

A. Product Data Sheets: Submit manufacturer’s data sheet for the lighting control system and specified components

B. Panel Drawings: Submit manufacturer’s dimensional drawings and circuit breaker placement locations for each panelboard.

C. One Line Diagram: Submit a one-line diagram of the system configuration proposed if it differs from that illustrated in the riser diagram included in these specifications.

D. Typical Wiring Diagrams: Submit typical connection diagrams for all components including, but not limited to, panelboards, low voltage switches, occupancy sensors, light level controllers, communications devices, and personal computers.

E. Substitutions: If a system from another manufacturer is submitted for approval, the following submittals are required: Short circuit study demonstrating NEC110-10 compliance for all remotely-operated switching devices. Elevation drawing showing placement of equipment in equipment rooms.

PART 2 - MATERIALS AND COMPONENTS

2.01 NETWORK LIGHTING CONTROLS SYTEM

A. DIGITAL OCCUPANCY CONTROL SYSTEM

1. Basis of design product: Wattstopper Digital Lighting Management (DLM) or subject to compliance and prior approval with specified requirements of this section, one of the following:

   a. Watt Stopper; Legrand Group (Basis of Design)
   b. nLight: Acuity Brands.

2. Digital Ceiling mounted occupancy sensor system.
    a. Ceiling mounted passive infrared (PIR), ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor. Furnish the Company's system which accommodates the square-foot coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors and accessories which suit the lighting and electrical system parameters.
    b. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
        1) Digital calibration and pushbutton programming for the following variables:
            a) Sensitivity – 0-100% in 10% increments
            b) Time delay – 1-30 minutes in 1-minute increments
            c) Test mode – Five second time delay
            d) Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
            e) Walk-through mode
            f) Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photo sensors are included in the DLM local network.
        2) One or two RJ-45 port(s) for connection to DLM local network.
        3) Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
        4) Device Status LEDs including:
            a) PIR Detection
            b) Ultrasonic detection
            c) Configuration mode
            d) Load binding
        5) Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
        6) Manual override of controlled loads.
    c. Units shall not have any dip switches or potentiometers for field settings.
    d. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.
    e. WattStopper product numbers: LMPX, LMDX, LMPC, LMUC, LMDC

B. DIGITAL WALL SWITCHES
1. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration; available in white, light almond, ivory, grey and black; compatible with wall plates with decorator opening. Wall switches shall include the following features:
    a. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.

b. Removable buttons for field replacement with engraved buttors and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
c. Red configuration LED on each switch that blinks to indicate data transmission.
d. Blue Load/Scene Status LED on each switch button with the following characteristics:

    a) Bi-level LED
    b) Dim locator level indicates power to switch
    c) Bright status level indicates that load or scene is active

e. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.

2. Two RJ-45 ports for connection to DLM local network.
3. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required to achieve multi-way switching.
4. The following switch attributes may be changed or selected using a wireless configuration tool:
    a. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
    b. Individual button function may be configured to Toggle, On only or Off only.
    c. Individual scenes may be locked to prevent unauthorized change.
    d. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
    e. Ramp rate may be adjusted for each dimmer switch.
    f. Switch buttons may be bound to any load on a room controller and are not load type dependant; each button may be bound to multiple loads.
5. WattStopper product numbers: LMSW-101, LMSW-102, LMSW-103, LMSW-104, LMSW-105, LMSW-108, LMDM-101.

C. ROOM CONTROLLERS

1. Room Controllers automatically bind the room loads to the connected devices in the space without commissioning or the use of any tools. Room Controllers shall be provided to match the room lighting load and control requirements. The controllers will be simple to install and will not have, dip switches, potentiometers or require special configuration. The control units will include the following features:
    a. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
    b. Simple replacement – Using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf unit without requiring any configuration or setup.
    c. Device Status LEDs to indicate:
        1) Data transmission
        2) Device has power
        3) Status for each load
        4) Configuration status
    d. Quick installation features including:
        1) Standard junction box mounting
        2) Quick low voltage connections using standard RJ-45 patch cable
    e. Plenum rated
    f. Manual override and LED indication for each load
    g. Dual voltage (120/277 VAC, 60 Hz)
    h. Zero cross circuitry for each load.
2. On/Off Room Controllers shall include:
    a. One or two relay configuration
    b. Efficient 150 mA switching power supply
    c. Three RJ-45 DLM local network ports
    d. Discrete model listed for connection to receptacles, for occupancy-based control of plug loads within the space.

d. One relay configuration only

1) Automatic-ON/OFF configuration

e. WattStopper product numbers: LMRC-101, LMRC-102, LMPL-101

3. On/Off/Dimming enhanced Room Controllers shall include:
    a. Real time current monitoring
    b. One, two or three relay configuration
    c. Efficient 250 mA switching power supply
    d. Four RJ-45 DLM local network ports.
    e. One 0-10 volt analog output per relay for control of compatible ballasts and LED drivers.
    f. Optional Network Bridge for BACnet MS/TP communications (LMRC-3xx).
    g. The following dimming attributes may be changed or selected using a wireless configuration tool:
        1) Establish preset level for each load from 0-100%
        2) Set high and low trim for each load
        3) Set lamp burn in time for each load up to 100 hours
    h. Discrete model listed for connection to receptacles, for occupancy-based control of plug loads within the space.
        1) One relay configuration only
        2) Automatic-ON/OFF configuration
    i. WattStopper product numbers: LMRC-211, LRMC-212, LRMC-213, LMPL-201, LMRC-311, LMRC-312, LMRC-313.
    j. Isolated Relay Interface
        1) With each room controller, provide an isolated relay interface (as required) Wattstopper LMRL-100 for local control of HVAC equipment per mechanical details.
        2) The LMRL-100 contains a single-pole, double throw isolated relay and normally open (N/O), normally closed (N/C) and common outputs.

D. ROOM NETWORK (DLM Local Network)

1. The DLM local network is a free topology lighting control physical connection and communication protocol designed to control a small area of a building. Digital room devices connect to the network using CAT 5e cables with RJ-45 connectors which provide both data and power to room devices. Features of the DLM local network include:
    a. Plug n' Go automatic configuration and binding of occupancy sensors, switches and lighting loads to the most energy-efficient sequence of operation based upon the device attached.
    b. Simple replacement of any device in the network with a standard off the shelf unit without requiring commissioning, configuration or setup.
    c. Push n' Learn configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices in the local network.
    d. Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30 feet from a sensor, wall switch or IR receiver.

E. CONFIGURATIONS TOOLS

1. A configuration tool facilitates optional customization of DLM local networks, and is used to set up open loop daylighting sensors. A wireless configuration tool features infrared communications, while PC software connects to each local network via a USB interface.
2. Features and functionality of the wireless configuration tool shall include:
    a. Two-way infrared (IR) communication with DLM IR-enabled devices within a range of approximately 30 feet.
    b. High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation.
    c. Read, modify and send parameters for occupancy sensors, room controllers and buttons on digital wall switches.
    d. Save up to nine occupancy sensor setting profiles, and apply profiles to selected sensors.
    e. Temporarily adjust light level of any load(s) on the local network, and incorporate those levels in scene setting.
3. WattStopper Product Numbers: LMCT-100, LMCI-100/LMCS-100

F. NETWORK BRIDGE

1. The network bridge connects a DLM local network to a BACnet-compliant network for communication between rooms, panels and a segment manager or BAS. Each local network shall include a network bridge component to provide a connection to the local network room devices. The network bridge shall use industry standard BACnet MS/TP network communication.
    a. The network bridge may be incorporated directly into the room controller hardware (LMRC-3xx Room Controllers) or be provided as a separate module connected on the local network through an available RJ-45 port.
    b. Provide Plug n' Go operation to automatically discover all room devices connected to the local network and make all device parameters visible to the segment manager via the segment network. No commissioning shall be required for set up of the network bridge on the local network.
    c. The network bridge shall automatically create standard BACnet objects for selected room device parameters to allow any BACnet-compliant BAS to include lighting control and power monitoring features as provided by the DLM room devices on each local network. Standard BACnet objects shall be provided as follows:
        1) Read/write the normal or after hours schedule state for the room
        2) Read the detection state of the occupancy sensor
        3) Read/write the On/Off state of loads
        4) Read/write the dimmed light level of loads
        5) Read the button states of switches
        6) Read total current in amps, and total power in watts through the room controller
        7) Read/write occupancy sensor time delay, PIR sensitivity and ultrasonic sensitivity settings
        8) Activate a preset scene for the room
        9) Read/write daylight sensor fade time and say and night setpoints
        10) Read the current light level, in footcandles, from interior and exterior photosensors and photocells

11) Set daylight sensor operating mode
12) Read/write wall switch lock status

d. WattStopper product numbers: LMBC-300

G. SEGMENT MANAGER (Provide one for Res Hall 1 and Res Hall 2/Dining)

1. The Digital Lighting Management system shall include at least one segment manager to manage network communication. It shall be capable of serving up a graphical user interface via a standard web browser. Each segment manager shall have support for one, two or three segment networks as required and allow for control of a maximum of 127 local networks (rooms) and/or lighting control panels per segment network.
2. Operational features of the Segment Manager shall include the following:

a. Connection to PC or LAN via standard Ethernet TCP/IP.
b. Easy to learn and use graphical user interface, compatible with Internet Explorer 8, or equal browser.
c. Log in security capable of restricting some users to view-only or other limited operations.
d. Automatic discovery of all DLM devices on the segment network(s). Commissioning beyond activation of the discovery function shall not be required.
e. After discovery, all rooms and panels shall be presented in a standard navigation tree format. Selecting a device from the tree will allow the device settings and operational parameters to be viewed and changed by the user.

f. Ability to view and modify room device operational parameters. It shall be possible to set device parameters independently for normal hours and after hours operation.
g. Ability to set up schedules for rooms and panels. Schedules shall automatically set controlled zones or areas to either a normal hours or after hours mode of operation.
h. Ability to group rooms and loads for common control by schedules, switches or network commands.
i. Ability to monitor connected load current and display power consumption for areas equipped with room controllers incorporating the integral current monitoring feature.

3. Provide seamless integration with the BAS via BACnet IP

   a. WattStopper Product Numbers: LMSM-201, LMSM-603.

4. LMCP Digital Lighting Management Relay Panel

   a. Provide up to 8, 24 or 48 (number of relays as noted on the drawings) mechanically latching relays. Relays include a manual override and a single push on connector for easy installation of removal from the panel. Panel accepts program changes from handheld configuration tool for date and time, location, holidays, event scheduling, button binding and group programming. Provides BACnet MS/TP compliant digital networked communication between other lighting controls and or building automation system (BAS).
   b. Enclosure shall be NEMA 1 sized to accept an interior with 1-24 relays and 6 four pole contactors. (or 1-48 relays and 6 four pole contactors). Number of relays as noted on the drawings.
   c. Cover shall be configured for surface wall mounting. Panel shall have a hinged and lockable door with restricted access to line voltage section of the panel.
   d. Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. The interior construction shall provide total isolation of high voltage (Class 1) wiring from low voltage (Class 2) wiring within the assembled panel. The interior assembly shall include intelligence boards, power supply, DIN rails for mounting optional Class 2 control devices, and individually replaceable latching type relays. The panel interiors shall include the following features:
   e. Removable, plug-in terminal blocks with connections for all low voltage terminations.
   f. Individual terminal block, override pushbutton, and LED status light for each relay.
   g. Direct wired switch inputs associated with each relay shall support 2-wire momentary switches only.
   h. Digital inputs (four RJ-45 jacks) shall support 1-, 2-, 3-, 4-, and 8-button digital switches; digital IO modules capable of receiving 0-5V or 0-10V analog photocell inputs; digital IO modules capable of receiving momentary or maintained contact closure inputs or analog sensor inputs; digital daylighting sensors; and digital occupancy sensors. Inputs are divided into two separate digital networks, each capable of supplying 250mA to connected devices.

i. True relay state shall be indicated by the on-board LED and shall be available to external control devices and systems via BACnet.
j. Automatically sequenced operation of relays to reduce impact on the electrical distribution system when large loads are controlled simultaneously.
k. Group and pattern control of relays shall be provided through a simple keypad interface from a handheld IR programmer. Any set of relays can be associated with a group for direct on/off control or pattern (scene) control via a simple programming sequence using the relay override pushbuttons and LED displays for groups 1-8 or a handheld IR programmer for groups 1-99.
l. Relay group status for shall be provided through LED indicators for groups 1-8 and via BACnet for groups 1-99. A solid LED indicates that the last group action called for an ON state and relays in the group are on or in a mixed state.

m. Single pole latching relays with modular plug-in design. Relays shall provide the following ratings and features:

1) Electrical:

a) 20amp tungsten at 120V
b) 1.5 HP motor at 120V
c) Relays shall be specifically UL 20 listed for control of plug-loads

2) Mechanical:

a) Replaceable, ½" KO mounting with removable Class 2 wire harness.
b) Actuator on relay housing provides manual override and visual status indication, accessible from Class 2 section of panel.
c) Dual line and load terminals each support two #14 - #12 solid or stranded conductors.
d) Tested to 300,000 mechanical on/off cycles.

n. Isolated low voltage contacts provide for true relay status feedback and pilot light indication.

o. Power supply shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements. Power supply to have internal over-current protection with automatic reset and metal oxide varistor protection.

p. Where indicated, lighting control panels designated for control of emergency lighting shall be provided with factory installed provision for automatic by pass of relays controlling emergency circuits upon loss of normal power. Panels shall be properly listed and labeled for use on emergency lighting circuits and shall meet the requirements of UL924 and NFPA 70 - Article 700.

q. Integral system clock shall provide scheduling capabilities for panel. (Dining facility CDS) Panel is intended to stand alone and not be tied into the DLM Segment manager system on the Residence Hall Side.

r. Each panel shall include digital clock capability able to issue system wide automation commands to up to (11) eleven other panels for a total of (12) twelve networked lighting control panels. The clock shall provide capability for up to 254 independent schedule events per panel for each of the ninety-nine system wide channel groups.

s. The clock capability of each panel shall support the time-based energy saving requirements of applicable local energy codes.

t. The clock module shall provide astronomic capabilities, time delays, blink warning, daylight savings, and holiday functions and will include a battery back up for the clock function and program retention in non-volatile FLASH memory. Clocks that require multiple events to meet local code lighting shut off requirements shall not be allowed.

u. The clock capability of each panel shall operate on a basis of ON/OFF or Normal Hours/After Hours messages to automation groups that implement pre-configured control scenarios. Scenarios shall include:

1) Scheduled ON / OFF
2) Manual ON / Scheduled OFF
3) Astro ON / OFF (or Photo ON / OFF)

4) Astro and Schedule ON / OFF (or Photo and Schedule ON / OFF)

v. The user interface shall be a portable IR handheld remote control capable of programming any panel in the system (LMCT-100)

w. The clock capability of each panel shall employ non-volatile memory and shall retain user programming and time for a minimum of 10 years.

x. Schedules programmed into the clock of any one panel shall be capable of executing panel local schedule or Dark/Light (photocell or Astro) events for that panel in the event that global network communication is lost. Lighting control panels that are not capable of executing events independently of the global network shall not be acceptable.

5. The lighting control panel can operate as a stand-alone system, or can support schedule, group, and photocell control functions, as configured in a Segment Manager controller, via a segment network connection. (at this time it will not be tied into the segment manager)

6. The lighting control panel shall support digital communications to facilitate the extension of control to include interoperation with building automation systems and other intelligent field devices. Digital communications shall be RS485 MS/TP-based using the BACnet® protocol.

    a. The panel shall have provision for an individual BACnet device ID and shall support the full 222 range (0 – 4,193,304). The device ID description property shall be writable via the network to allow unique identification of the lighting control panel on the network.
    b. The panel shall support MS/TP MAC addresses in the range of 0 - 127 and baud rates of 9600k, 38400k, 76800k, and 115.2k bits per second.
    c. Lighting control relays shall be controllable as binary output objects in the instance range of 1 - 64. The state of each relay shall be readable and writable by the BAS via the object present value property.
    d. Lighting control relays shall report their true on/off state as binary input objects in the instance range of 1 - 64.
    e. The 99 group Normal Hours/After Hours control objects associated with the panel shall be represented by binary value objects in the instance range of 201 - 299. The occupancy state of each channel group shall be readable and writable by the BAS via the object present value property. Commanding 1 to a channel group will put all relays associated with the channel into the normal hours mode. Commanding 0 or NULL shall put the relays into the after-hours mode.
    f. Setup and commissioning of the panel shall not require manufacturer-specific software or a computer. All configuration of the lighting control panel shall be performed using standard BACnet objects or via the handheld IR programming remote. Provide BACnet objects for panel setup and control as follows:
    g. Binary output objects in the instance range of 1 - 64 (one per relay) for on/off control of relays.
    h. Binary value objects in the instance range of 1 - 99 (one per channel) for normal hours/after hours schedule control.
    i. Binary input objects in the instance range of 1 - 64 (one per relay) for reading true on/off state of the relays.
    j. Analog value objects in the instance range of 101 - 199 (one per channel group) shall assign a blink warn time value to each channel. A value of 5 shall activate the blink warn feature for the channel and set a 5-minute grace-time period. A value of 250 shall activate the sweep feature for the channel and enable the use of sweep type automatic wall switches.
    k. The description property for all objects shall be writable via the network and shall be saved in non-volatile memory within the panel.
    l. The BO and BV 1 - 99 objects shall support BACnet priority array with a relinquish default of off and after hours respectively. Prioritized writes to the channel BV objects shall propagate prioritized control to each member relay in a way analogous to the BACnet Channel object described in addendum aa. (http://www.bacnet.org/Addenda/Add-135-2010aa.pdf)

m. Panel-aggregate control of relay Force Off at priority 2 shall be available via a single BV5 object. Force On at priority 1 shall be available via a single BV4 object.
n. Lockout of all digital switch buttons connected to a given panel shall be command-able via a single BV2 object. The lock status of any connected switch station shall be represented as BV101-196.

7. Emergency Lighting Control Unit (ELCU)

a. Allows a standard lighting control device to control emergency lighting in conjunction with normal lighting in any area within a building.

H. SWITCHBOX-MOUNTED OCCUPANCY SENSORS

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
a. Bryant Electric; a Hubbell company.
b. Cooper Industries, Inc.
c. Hubbell Building Automation, Inc.
d. Leviton Mfg. Company Inc.
e. Lithonia Lighting; Acuity Lighting Group, Inc.
f. Lutron Electronics Co., Inc.
g. Sensor Switch, Inc.
h. Square D; a brand of Schneider Electric.
i. Watt Stopper.

2. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.

a. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
b. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
c. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.

3. Wall-Switch Sensor Tag ‘MS’:

a. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft.
b. Sensing Technology: Dual technology - PIR and ultrasonic.
c. Switch Type: SP.
d. Voltage: Dual voltage, 120 and 277 V; dual-technology type.
e. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
f. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

I. LIGHTING CONTACTORS

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Allen-Bradley/Rockwell Automation.
b. ASCO Power Technologies, LP; a division of Emerson Electric Co.
c. Eaton Corporation.
d. General Electric Company; GE Consumer & Industrial - Electrical Distribution; Total Lighting Control.

e. Square D; a brand of Schneider Electric.
f. TORK
g. Watt Stopper (The)

2. Description: Electrically operated and electrically held, combination-type lighting contactors, complying with NEMA ICS 2 and UL 508.

   a. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).

   b. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.

   c. Enclosure: Comply with NEMA 250.

   Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

2.02 NETWORKS

A. Ethernet Network:

1. Installing contractor shall coordinate work with the network administrator to assure that proper connection points are available. The installing contractor shall also secure static IP address for each individual master controller and power monitoring web server.
2. Network shall support Ethernet 10Base-T communications.
3. Communications wiring to master panels shall be Category 5 cable having 8 position 8 contact (8P8C) modular plugs terminated using the T568A or T568B pin/pair assignments as defined in TIA/EIA-568-B.

B. Communications wiring to master panels shall use Category 5 cabling. Installing contractor shall coordinate work with the network administrator to assure that proper connection points are available. The installing contractor shall also secure one static IP address for each master controller.

PART 3 – EXECUTION

3.01. CUSTOMIZATION

A. Manufacturer shall provide any custom hardware or communication devices necessary to make the system perform as specified above.

B. Manufacturer shall provide PC user interface custom screens. Rough layouts of the screens will be provided to the manufacturer no less than 30 days before scheduled system start-up.

3.02. CONTRACTOR INSTALLATION

A. Install equipment in accordance with manufacturers installation bulletins.

B. Provide complete installation in accordance with contract documents.

C. Define each circuit breaker, dimmer, relay load type and assign to required zone, input and/or schedule.

D. Provide-as built drawings indicating sensor placements on drawings.

E. Provide one-line drawing indicating location and addresses of all networked hardware including panels, distributed relays and dimmers, keypads, and sensors

F. SENSOR INSTALLATION

1. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
2. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.
3. When using wire for connections other than the DLM local network (Cat 5e with RJ-45 connectors), provide detailed point to point wiring diagrams for every termination. Provide wire specifications and wire colors to simplify contactor termination requirements

4. Install the work of this Section in accordance with manufacturer's printed instructions unless otherwise indicated.

G. Perform the following tests and inspections with the assistance of a factory-authorized service representative. Owner shall be provided the opportunity to witness all testing.

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

H. Re-commissioning – After 30 days from occupancy re-calibrate all sensor time delays and sensitivities to meet the Owner's Project Requirements. Provide a detailed report to the Architect / Owner of re-commissioning activity.

I. Lighting control devices will be considered defective if they do not pass tests and inspections.

J. Provide written or computer-generated documentation on the commissioning of the system including room by room description including:

1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
3. Load Parameters (e.g. blink warning, etc.)

K. Prepare test and inspection reports.

L. WIRING INSTALLATION

1. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 3/4 inch.
2. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
3. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
4. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

M. IDENTIFICATION

1. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."
    a. Identify controlled circuits in lighting contactors.
    b. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
2. Label time switches and contactors with a unique designation.

3.03. SYSTEM PROGRAMMING

A. Contractor is responsible for furnishing fully functional system including all necessary programming, calibration, and operational interfaces to other devices.

B. Contractor shall meet with owner's representative to identify desired operation of the control system. At minimum, the lighting control system shall meet the functional requirements of the applicable energy building code for the location of the property.

C. Contractor shall fully document the control operation of the system including zone definitions, time schedules, input assignments, scenes, dimmer setpoints, occupancy sensor delays, light level settings, and any other special requirements including information that is to be shared with other building systems. Full documentation shall be made available to the owner's rep and the manufacturer no less than 14 days before planned start up.

3.04. START-UP

A. Installing contractor shall provide factory-certified field service for site inspection to assure proper system installation and operation.

3. Factory service technicians shall:

g. Have certification demonstrating competency with associated controls systems

h. Be certified by the manufacture on the system installation and programming.

4. Upon visit, the technician will be responsible for performing the following:
    a. Verify power feeds and load circuits are properly labeled according to drawings
    b. Verify connection and location of all external controls
    c. Verify addressing of all network components in relation to drawings
    d. Verify equipment is properly operating in accordance with approved drawings and sequence of operations
    e. Verify operation of supplied interfaces with other equipment
    f. Verify sensors are properly calibrated
    g. Obtain sign-off on system functions

3.05. FACTORY COMMISSIONING.

B. Upon completion of the installation, the system shall be commissioned by the manufacturer's factory authorized representative who will verify a complete fully functional system.

C. The electrical contractor shall provide both the manufacturer and the electrical engineer with ten working days written notice of the system startup and adjustment date

END OF SECTION 260926

SECTION 262200 - LOW VOLTAGE TRANSFORMERS

General

WORK INCLUDES

Dry-type transformers, 600 Volts and below, and 1000 kVA maximum:

General Lighting and Distribution Type

SUBMITTALS

Submit in accordance with Division 1, Section 01300.

Product Data: Submit manufacturer's technical product data including rated kVA, frequency, primary and secondary voltages, percent taps, polarity, impedance, temperature rise above 40 deg. C ambient temperature, sound level in decibels, and standard published data.

Operation & Maintenance Data: Submit operation & maintenance data for each type of transformer installed, including furnished specialties and accessories. Include this data, product data, and shop drawings in an "Operation & Maintenance" manual, in accordance with requirements of the General Conditions of this Specification.

Shop Drawings: Submit manufacturer's drawings indicating dimensions, and weight loadings for transformer installations, showing layouts, mountings and supports.

Nameplate Drawing: Submit nameplate drawing with all information filled-out for each rating of transformer, including phasor diagram and wiring diagram.

QUALITY ASSURANCE

Codes and Standards

NFPA 70-National Electrical Code

NEMA Standards

ANSI Standards

Acceptable Manufacturers:

General Electric Co.

Siemens-ITE

Sorgel Electric Div; Square D Co.

Westinghouse Electric Corp.

products

LIGHTING & DISTRIBUTION TYPE TRANSFORMERS

Provide factory-assembled, general-purpose, ventilated, dry-type distribution transformers where shown; of rated kVA capacities indicated; 3-phase, 60-hertz.

Primary winding rated 480 volt delta and secondary winding rated 120/208 volt, 4 wire wye. Provide primary windings with 6 full kVA capacity taps; 2 @ 2-1/2% increments above rated voltage and 4 @ 2-1/2% increments below rated voltage for de-energized tap-changing operation.

Transformer shall be rated for continuous operation, at rated kVA, without exceeding a total winding temperature, as indicated below:

	Insulation System Classification		
	Amb	Avg Wdg Temp	Hot Spot
Class 150C	40°C	80°C	30°C
Class 185C	40°C	115°C	30°C
Class 220C	40°C	150°C	30°C

Note: While Class 220C insulation system materials are acceptable, the maximum total winding temperature shall be as indicated above.

Mount vibration isolation supports between the core and coil assembly and the transformer enclosure base; electrically ground core to transformer enclosure by means of a flexible metal grounding strap.

Do not exceed maximum NEMA sound-levels as follows:

0 - 50 kVA	45db
51 - 150	50
151 - 300	55
301 - 500	60
501 - 700	62
701 - 1000	64

An electrostatic shield shall be placed between the primary and secondary windings.

Provide transformers with a ventilated steel enclosure containing access panels. Apply ANSI 61 light gray enamel over cleaned and phosphatized steel enclosure. The maximum surface temperature of the enclosure top shall not exceed 90°C. Furnish weathershields for outdoor installations.

Provide engraved laminated plastic equipment/system identification nameplates complying with Division 26 Basic Electrical Materials and Methods section and “Identification for Electrical Systems" section.

execution

INSTALLATION

Install transformers at locations indicated and complying with manufacturer's instructions, applicable requirements of NEC, NEMA, ANSI and IEEE standards.

Coordinate transformer installation work with electrical raceway and wire/cable work, as necessary for proper interface.

Connect transformer units to electrical wiring system complying with requirements of other Division-26 sections.

Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std. 486A.

Provide equipment enclosure grounding and system neutral grounding connections as indicated and as required by NEC.

FIELD TESTING

Prior to energization of transformers, check all accessible connections for compliance with manufacturer's torque tightening specifications. Check and record tap setting.

Prior to energization measure and record winding insulation resistance using a 500 volt megger

Upon completion of installation of transformers, energize primary circuitry at rated voltage and frequency from normal power source, and test transformers, including, but not limited to, the following:

No load secondary voltage and tap setting

Secondary voltage with maximum available load applied

Enclosure surface temperature at maximum available load

Audible sound levels at no load and at maximum available load

Include field testing reports in the operation & maintenance data specified under Submittals.

END OF SECTION

SECTION 26 24 13 - LOW VOLTAGE DISTRIBUTION PANELBOARDS

General

WORK INCLUDES

Metal enclosed low voltage (600-volt) power circuit breaker distribution panelboards.

This section includes requirements for distribution panelboard, including main breaker(s), and distribution overcurrent protective devices.

SUBMITTALS

Submit in accordance with Division 1, Section 01300.

Product Data: Submit manufacturer's technical product data covering the entire assembly, circuit breakers, trip units, control and metering components. Data shall also indicate voltage, phase, frequency, current rating and short circuit rating of the switchgear. Include assembly storing, handling, and installation instructions.

Operation & Maintenance Data: Submit operation & maintenance data including parts lists, furnished assembly, specialties and accessories. Include this data, product data, and shop drawings in "Operation & Maintenance" manual, in accordance with requirements of the General Conditions of this Specification.

Shop Drawings: Submit the following types of manufacturer's drawings:

Outline assembly drawings indicating dimensions, and weight loadings, bus work layouts and mountings, device layouts, assembly structural details, mountings and supports;

One-line diagram of switchgear indicating ratings, of all devices, device types, bussing and lug capacities;

External connections and internal wiring diagrams;

Control schematic diagrams;

Scale front, rear, and end views of equipment with material list device catalog sheets, and nameplate schedule;

Sectional view of each section of panelboard or transfer switch showing construction, size and location of bussing and cabling furnished;

AIC/Fault current ratings of all equipment.

Schematic and Wiring Diagrams (including point by point) for circuit breaker controls, alarms, terminal blocks and all connections within the switchboard;

Complete detailed instructions on operation;

Coordination curves for each type and size breaker and fuse used;

Detail factory installed wiring and connections to be field provided;

Metering provisions;

Upon completion of project provide to the owner two (2) copies of manufactures as-built design drawings including bill of material with part and catalog numbers.

STANDARDS

Comply with the following latest editions of standards as applicable:

UL 891 Deadfront Switchboard

NEMA PB-2 - Ground Fault Protection Devices
NEMA SG3 - Low Voltage Power Circuit Breakers
ANSI C37.90 - Relays and Relay Systems Associated with Electric Power Apparatus
ANSI Z55.1 - Gray Finishes for Industrial Apparatus and Equipment
ANSI C37.13 - Low-Voltage AC Power Circuit Breakers Used in Enclosures
ANSI C37.16 - Preferred Ratings, Related Requirements and Application Recommendations for Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors
ANSI C37.17 - Trip Devices for AC and General Purpose DC Low-Voltage Power Circuit Breakers
ANSI C37.50 - Test Procedures for Low-Voltage AC Power Circuit Breakers Used in Enclosures
UL 44 - Electric Wires and Cables
UL 977 - Fused Power Circuit Devices
IEEE Std. 242, Chapter 7 - Ground-Fault Protection

seismic requirements

This panelboard is located in a seismic zone zero. Switchboard shall be constructed with all necessary bracing required for installation in specified seismic zone.

products

PANELBOARD CONSTRUCTION:

Panelboard assembly shall be enclosed in a steel cabinet. The rigidity and gauge of steel to be as specified in UL Standard 50 for cabinets. The size of wiring gutters shall be in accordance with UL Standard 67. Cabinets to be equipped with latch and tumbler-type lock on door of trim. Doors over 48" long shall be equipped with three-point latch and vault lock. All locks shall be keyed alike. Endwalls shall be removable. Fronts shall be of code gauge steel. Gray baked enamel finish electro-deposited over cleaned phosphatized steel.

The panelboard interior assembly shall be dead front with panelboard front removed. Main lugs or main breakers shall have barriers on five sides. The barrier in front of the main lugs shall be hinged to a fixed part of the interior. The end of the bus structure opposite the mains shall have barriers.

Panelboard bus structure and main breaker shall have current ratings as shown on the panelboard schedule. Such ratings shall be established by heat rise tests with maximum hot spot temperature on any connector or bus bar not to exceed 50 degrees C rise above ambient. Heat rise tests shall be conducted in accordance with Underwriters Laboratories Standard UL 67. The use of conductor dimensions will not be accepted in lieu of actual heat tests.

MISCELLANEOUS

Each panelboard, a complete unit, shall have a short circuit current rating equal to or greater than the integrated equipment rating shown on the panelboard schedule or on the plans. This rating shall be established by testing with the overcurrent devices mounted in the panelboard. The short circuit tests on the overcurrent devices and on the panelboard structure shall be made simultaneously by connecting the fault to each overcurrent device with the panelboard connected to its rated voltage source. Method of testing shall be per Underwriters Laboratories Standard UL 67. The source shall be capable of supplying the specified panelboard short circuit current or greater. Testing of panelboard overcurrent devices for short circuit rating only while individually mounted is not acceptable. Also, testing of the bus structure by applying a fixed fault to the bus structure alone is not acceptable. Panelboards shall be marked with their maximum short circuit current rating at the supply voltage and shall be UL listed.

Provide UL listed ground sensor relay (GSR) system with Ground-Break components for main breaker, if 1000-amps or larger. Each unit shall consist of a coordinated ground sensor (CT) with integral test winding, solid state relay to operate shunt trip circuit on circuit protective device and Monitor panel. Relay shall be of the zone selective interlock type and have continuously adjusted current pick-up settings of 100-1200 ampere and continuously adjustable time delay setting from Inst. (.03 sec.) to 1 second. Relay shall provide two independent output contacts each rated five amperes continuous and 30 amperes inrush at (24, 36, 48, 125 V dc or 120, 120/208, 120/240 V ac). Relay shall include a memory function to recognize and initiate tripping on intermittent ground faults. Monitor panels shall indicate relay operation and provide means for testing system with or without interruption of service and must not permit ground fault system to be inadvertently left in an inactive or OFF state. Ground sensor shall be installed for ground return or zero sequence arrangement as required on main service device. On feeder and branch devices, furnish zero sequence sensor arrangements. System shall be G.E. type "Ground-Break" or equivalent by Square "D" Company.

All bussing shall be copper with silver plated connection points. Load connection points shall not exceed a 65°C temperature.

The thru bus shall be drilled and plated to allow for the addition of future sections.

The neutral bus shall be fully rated with bus material to match the main bus. Neutral bus shall be isolated from ground and drilled for field connection to Owner's grounding electrode system.

Finish shall consist of a rust resisting primer and an ANSI 61 light gray final coat.

Overcurrent Protective Devices

Molded Case Circuit Breakers:

Provide distribution and power panelboards as indicated in the panelboard schedule and where shown on the plans. Panelboards shall be equipped with thermal-magnetic, molded case circuit breakers of frame and trip ratings as shown on the schedule. Branch circuit breakers shall be Square "D" FA, KA, LA, MA, NH, PA and/or PC one, two or three pole molded case circuit breakers rated 15 through 2500 amperes, (120 V ac) (240 V ac) (277 V ac) (480 V ac), as specified on the drawings. Breakers shall be standard construction. All circuit breakers shall be UL and CSA listed, IEC 157-1 rated, meet NEMA Standard AB1-1975 and Federal Specification W-C-375B/GEN, when applicable. Molded case circuit breakers shall have over center toggle-type mechanisms, providing quick-make, quick-break action. Breakers shall be calibrated for operation in an ambient temperature of 40oC. Each circuit breaker shall have trip indication by handle position and shall be trip-free. Two and three pole breakers shall be common trip. Each circuit breaker shall have a permanent trip unit containing individual thermal and magnetic trip elements in each pole. Circuit breakers with frame sizes greater than 100 amperes shall have variable magnetic trip elements which are set by a single adjustment (to assure uniform tripping characteristics in each pole). A push-to-trip button shall be provided on the cover from mechanically tripping the circuit breaker. The circuit breaker shall have reverse connection capability and be suitable for mounting and operating in any position. Unless otherwise indicated, branch circuit breakers up to 100 amperes shall have 10,000 RMS short circuit amperes symmetrical interrupting capacity. Circuit breakers above 100 ampere shall have 42,000 RMS capacity.

Overcurrent protection for feeders shall be provided by individually mounted molded case circuit breakers. Breakers shall be provided as indicated on drawings (80%/100%) equipped with adjustable solid state/digital long time pickup and delay, short time pickup and delay, and instantaneous pickup trip units. Provide zero sequence ground fault trip with adjustable pickup (100-1200A and adjustable time delay, minimum of 3 settings. Provide trip indicators for all functions. Breakers rated 600 volts with minimum interrupting rating of 42,000 rms symmetrical amperes at 480 volts. Breakers shall be plug-in connected or accepted equivalent. Equal breakers shall be General Electric "Spectra RMS", Siemens, "Sentron", or Cutler-Hammer/Westinghouse Electronic RMS.

Acceptable Switchboard manufacturers:

Square D

General Electric

Cutler-Hammer/Westinghouse

Siemens

execution

FACTORY TESTING:

Test the panelboard after fabrication at the factory as follows:

Simulate all control and relay functions.

Test complete operation of breakers including electric operation.

The Consultant's and the Owner's representative may witness factory tests, and review panelboard operation.

Inform the Consultant two weeks prior to tests, and arrange for representatives to be present at the time of tests.

The cost of Consultant's and Owner's expenses for the factory visit(s) will not be part of contract price.

FIELD TESTS AND TRAINING

Test new panelboard at the site before acceptance for service in accordance with manufacturer recommendations.

The Panelboard manufacturer shall furnish Owner's personnel operating and maintenance training at the site of the work for one (1) day at completion of construction. Time and date will be selected by Owner.

CABLE FEEDERS

Cable feeders shall be tied to insulated cable supports and neatly formed and laced. Identify cable feeders in cable compartment with laminated nameplates (Reference Section 260553) fastened to cable circuits with nylon ties. Nameplates shall identify feeder and destination of feeder; Reference Section 260553 “Identification for Electrical Systems” for further information.

INSTALLATION

Secure each cubicle to the pad with a minimum of two 1/2" anchor bolts secured to the concrete pad, or other approved structure.

Provide all necessary bracing, additional anchors, etc. as required to secure panelboard for Seismic zone specified above.

Install switchgear as indicated on the drawings and in accordance with NEC article 384 and NECA standards of installation.

Provide a 4" high concrete housekeeping pad with leveling channels for switchboard installation.

Prior to energizing panelboard verify the following:

Proper alignment and level of equipment

Proper torque of all bolted connections

Proper overcurrent device for load served

Proper adjustment and operation of all mechanisms and accessories

Touch up, repair and replace any damaged surfaces and devices.

END OF SECTION 262413

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes distribution panelboards and lighting and appliance branch-circuit panelboards.

1.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Include evidence of NRTL listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards.

C. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

D. Panelboard schedules for installation in panelboards.

E. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NEMA PB 1.

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Enclosures: Flush- and surface-mounted cabinets dead front design.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
b. Outdoor Locations: NEMA 250, Type 3R with gasketed door and lock assembly with all locks keyed alike.
c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
4. Directory Card: Inside panelboard door, mounted in transparent card holder.

C. Incoming Mains Location: Top and bottom.

D. Phase, Neutral, and Ground Buses: Tin-plated hard-drawn copper, 98 percent conductivity.

E. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Tin-plated hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus Configured Terminators: Mechanical type.
4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards with one or more main service disconnecting and overcurrent protective devices.

G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

H. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, and listed and labeled for series-connected short-circuit rating by an NRTL.

I. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following:

1. Square D; a brand of Schneider Electric.
2. Cutler Hammer / Eaton
3. Siemens
4. General Electric

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only with field convertible top or bottom feeds for incoming feed.

D. Minimum short circuit current rating of 22,000 in rms symmetrical amperes unless otherwise indicated.

E. Provide one continuous plated copper bus bar per phase. Provide solidly bonded copper equipment bus bar and additional isolated/insulated ground bar as specified.

F. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

G. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

H. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D; a brand of Schneider Electric.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with series-connected rating to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.

c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
e. Shunt Trip: (Voltage as prepared by Siemens) trip coil energized from separate circuit, set to trip at percent of rated voltage - As required by Siemens.
f. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in [off] position.
g. Handle Clamp: Loose attachment for holding circuit-breaker handle in on position.

2.4 ACCESSORY COMPONENTS AND FEATURES

A. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Mount top of trim 90 inches above finished floor unless otherwise indicated.

C. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

D. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

E. Install filler plates in unused spaces.

F. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads and incorporating Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Panelboards will be considered defective if they do not pass tests and inspections.

END OF SECTION 262416

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Wall-box motion sensors.
3. Snap switches and wall-box dimmers.
4. Solid-state fan speed controls.
5. Wall-switch and exterior occupancy sensors.
6. Communications outlets.

B. See Division 27 Section "Communications Horizontal Cabling" for workstation outlets.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

D. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 RECEPTACLES

A. Provide receptacles with automatic self-grounding clip, back and side wired with clamp-type terminals and additional features. Comply with UL 498 and NEMA WD 1. Receptacles shall be 120V, 20A, heavy duty grade.

1. Products: Subject to compliance with requirements, provide one of the following:
    a. Hubbell 5262 series or equal

2.3 INDUSTRIAL HEAVY DUTY RECEPTACLES

A. Provide pin and sleeve design receptacles conforming to UL 498. Comply with UL 1010 where installed in hazardous locations. Provide features indicated.

2.4 GFCI RECEPTACLES

A. Provide “feed-thru” type ground-fault circuit interrupter, with integral heavy-duty NEMA 5-20R duplex receptacles, test button, LED indicator lamp, and reset button arranged to protect connected downstream receptacles on same circuit. Provide unit designed for installation in a 2-3/4" deep outlet box without adapter, grounding type, Class A, Group 1, per UL Standard 94.3, heavy duty industrial grade.

2.5 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:
    a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
    b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
    c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
    d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

C. Pilot Light Switches, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:
    a. Cooper; 2221PL for 120 V and 277 V.
    b. Hubbell; HPL1221PL for 120 V and 277 V.
    c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
    d. Pass & Seymour; PS20AC1-PLR for 120 V.
3. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

D. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 1995.
b. Hubbell; HBL1557.
c. Leviton; 1257.
d. Pass & Seymour; 1251.

2.6 FAN SPEED CONTROLS

A. Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters. Comply with UL 1917.

1. Continuously adjustable slider, 5 A.
2. Three-speed adjustable slider, 1.5 A.

2.7 COMMUNICATIONS OUTLETS

A. Telephone Outlet:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; 3560-6.
   b. Leviton; 40649.
3. Description: Single RJ-45 jack for terminating 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1 complying with Category 5e. Comply with UL 1863.

B. Combination TV and Telephone Outlet:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; 3562.
   b. Leviton; 40595.
3. Description: Single RJ-45 jack for 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e; and one (1) Type F coaxial cable connector.

2.8 WALL PLATES

A. Single and combination, of types, sizes, and with gangin and cutouts as required. Provide plates which mate and match with wiring devices to which attached. Provide metal screws for securing plates to devices with screw heads colored to match finish of plates. Provide white color wall plates except in clean room, process areas or unfinished areas as indicated below. Provide wall plates with engraved legend or micarta label indicating panel and circuit number. Provide plates possessing the following additional construction features in clean rooms and process areas:

1. Clean Room
   a. Receptacle covers shall be specification grade grey polycarbonate, single lid covers with stainless steel hinges, gasket and stainless steel screws and of the in use type.
   b. Switch covers shall be 0.04” thick, type 304 satin finished stainless steel with flexible silicone bubble for switch actuation, with gasket and stainless steel screws. Pass & Seymour 4516 or equal.
2. Mechanical Room
   a. Wall plates shall be type 430 satin finish stainless steel
3. Unfinished Room
   a. Wall plates shall be galvanized steel.

2.9 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices: As selected by Architect, unless otherwise indicated or required by NFPA 70 or device listing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
    a. Cut back and pigtail, or replace all damaged conductors.
    b. Straighten conductors that remain and remove corrosion and foreign matter.
    c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.

9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

3.2 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 114 to 126 V.
2. Percent Voltage Drop under 15-A Load: A value of higher than 5% is not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new, and retest as specified above.

END OF SECTION 262726

SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Non-fusible switches.
2. Receptacle switches.
3. Shunt trip switches.
4. Molded-case circuit breakers (MCCBs).
5. Enclosures.

1.2 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

C. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.

D. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three (3) padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
3. Lugs: Suitable for number, size, and conductor material.

2.2 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

D. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Instantaneous trip.
2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.
4. Ground-fault pickup level, time delay, and I^2t response.

E. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

F. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.

2. Lugs: Suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.

4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
6. Auxiliary Contacts: One (1) SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
7. Alarm Switch: One (1) NO contact that operates only when circuit breaker has tripped.

2.3 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.
3. Kitchen or Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NECA 1.

3.2 IDENTIFICATION

A. Comply with requirements in Division 26 Section 260533, "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262816

SECTION 26 29 23 - VARIABLE FREQUENCY DRIVES

General

WORK INCLUDES

VARIABLE FREQUENCY DRIVES

0 HP. thru 75 HP

75 HP. and larger

SUBMITTALS

Submit in accordance with Division 1, Section 01340.

Product Data:

Submit manufacturer's data on variable frequency drive (VFD) systems, including descriptive literature, operating instructions, and maintenance and repair data, full size black line (24 X 36) indicating all power and control connections to the VFD Unit.

Shop Drawings:

Submit detailed shop drawings indicating information on load side filtering for line noise control, schematic and power and control connections for a complete system. Include all unit and enclosure dimensional data with shop drawings.

Submit manufacturer's data on variable Frequency drive systems, including descriptive literature, operating instructions, wiring diagrams and maintenance and repair data.

SUMMARY

Provide adjustable frequency drive system designed for continuous variable-torque (torque proportional to square speed).pump and fan duty as indicated on drawings; suitable for use on direct connected motors or motors connected by power transmission components, to pump or fan load.

Coordination with the respective equipment suppliers regarding exact horsepower and control arrangements and shall furnish and install variable Frequency drives as required for a complete and properly operating system. Coordinate with the Division 23 Contractor for control requirements.

QUALITY ASSURANCE

Manufacturer's Qualifications: Firms regularly engaged in manufacturer of voltage source variable Frequency drives of sizes, types and ratings required, whose products have been in satisfactory use in similar service for not less then ten (10) years.

Codes and Standards:

Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and NEC.

NEMA Compliance: Comply with applicable requirements of NEMA standards.

Variable Frequency drives shall be UL labeled or E.T.L. labeled. Variable Frequency drives shall meet I.E.E.E. 519 requirements. Variable Frequency drives shall meet National Electrical Code requirements for capacitor discharge.

PRODUCTS

ACCEPTABLE MANUFACTURERS

Manufacturers: Subject to compliance with the Requirements, provide new Variable Frequency Drive Units (VSD) as manufactured by one of the following:

Square D Electric Company
General Electric Company
Allen Bradley Company
ABB
Eaton.

products

GENERAL

Adjustable Frequency drive system shall be designed for continuous variable-torque (torque proportional to square speed). fan duty; suitable for use on direct connected motors or motors connected by power transmission components, to fan loads.

Coordination with the respective equipment suppliers regarding exact fan horsepower and control arrangements and shall furnish and install VSDs as required for a complete and properly operating system.

Adjustable Frequency drive system shall be designed for continuous operation at 480 Volts, three phase and the feeder ampacity requirements shall not exceed that as indicated on the drawings.

VARIABLE FREQUENCY DRIVES O HP. THRU 75 HP

General:

Variable Frequency Drives (VFD) shall provide variable speed operation through the use of an adjustable frequency inverter system. The units shall be factory furnished and assembled, complete with all necessary controls, circuitry, and hardware as required to provide the functions herein specified, and shall only require field connections; from the 480 volt (nominal), 3-phase, 3-wire power source; from the control circuitry; from motor leads to load side of the variable frequency controller.

The VFDs shall be manufactured by reputable companies having no less than seven (7) years experience in VFD technology.

Basic Design:

Variable Frequency Power and Logic Unit shall be constructed using completely solid state components.

Unit shall transform 480 volts, 3 phase, 60 Hertz input power into frequency and voltage controlled 3 phase output power; suitable to provide positive speed and torque control to standard induction motors.

Output through a multistage process; the first stage shall convert the AC utility 480 volts, 3 phase, 60 Hertz input power to a filtered, fixed DC voltage through the use of a full wave diode bridge. This shall be done to provide a minimum input power factor of .95 throughout the speed range. Drives employing a phase controlled Silicon Controlled Rectifier (SCR) front end will not be acceptable.

The second stage shall convert the fixed voltage DC to an adjustable level of DC through the use of a transistorized chopper or Silicone-Controlled Rectifier. This stage may be eliminated by use of equipment using a sine-coded pulse width modulated inverter.

The third stage shall invert the adjustable level of filtered DC into a frequency and voltage controlled 3 phase adjustable AC output for speed control, through the use of transistorized inverters, or gate-turn-off (GTO) devices. The variable frequency output of the inverters shall be accomplished by voltage source, current source, or sine-coded pulse width modulation schemes.

All stages of the VFD will not produce any electrical noise or harmonic distortion back onto the incoming AC power line that will cause any adverse affects to any electrical, electronic, digital, and electromechanical devices on the premises. Line filters or reactors shall be included and installed on each drive to eliminate any feed back onto the buildings AC electrical system.

Each unit shall include an internal contactor for across the line operation and transfer control circuitry for transferring operation from the inverter to the across the line operation at a constant speed. The contactor shall be located inside the variable speed controller cabinet and manual switch control shall be capable of transferring the motor power source from the variable speed controller to a bypass contactor located within the variable speed controller. The bypass system shall include safety circuitry to insure that no damage to the variable speed control device or the driven equipment will occur due to a change of operation. All normal control functions shall occur during both variable speed and bypass mode of operation.

Speed Control: Stepless throughout speed range under variable torque load on continuous basis.

Adjustable Frequency Control:

Control shall be accomplished using a full wave diode bridge rectifier, fixed DC section, and with minimum .95 power factor.

The VFD shall operate from 480V, 3-phase, 60Hz input power. Normal operation shall not be affected by variation in input voltage between 437V and 506V.

The VFD shall be provided with Gate Turn Off (GTO) devices or transistors for high reliability in output power switching circuit.

Control Operating Ambient Temperature Range: 32° F. to 104° F.

Output Power:

Output frequency does not vary with load; with any input frequency variations; with plus-or-minus 10% input voltage changes; or with temperature changes within ambient specification.

Output frequency adjustable in proportion to any of following:

4-20 mA DC analog signal
0-5 VDC analog signal
0-10 VDC analog signal

The VFD shall be inherently "soft starting" such that the motor will start at zero frequency and shall linearly ramp up to the setpoint frequency. Inrush current to the motor during starting, shall not exceed 115% of motor rated current. The VFD shall have built-in overload protection on each phase to the motor.

The output shall maintain constant RMS volts per cycle within 3% of an output frequency covering a range of 3 to 60 Hz. Voltage in the three phases of the output shall be balanced within 1%. Equipment size and power output shall be sufficient for the motor to which it is connected.

Variable Frequency Drive unit shall be furnished with rating not less than the motor nameplate rated full load running current.

Exact horsepower of the VFD shall be determined by the supplier of the VFD driven equipment.

Enclosure:

Provide Variable Frequency Drive unit in a free-standing, NEMA-1/NEMA 3R panel enclosure fabricated of code gauge cold-rolled steel. The door shall be flanged, gasketed and mounted on semi-concealed pinion type hinges. The entire enclosure shall be primed and finished with industrial texture paint. The electrical bus shall be copper at all connection points. The enclosure will contain all the air circulating fans and air filters that are required for ventilation and to prevent enclosure over-temperature cutouts. No external fans, condensers or heat exchangers shall be required for cooling of the unit due to cabinet heat buildup. All components and controls that are integral to the VFD enclosure shall be completely factory installed and prewired with labeled cable terminals for field connections.

Provide controller with over-voltage clamp preventing damage by regenerated energy from high inertia loads or unstable motors.

Control includes following:

Input reference clamp which prevents excessive reference signal from affecting control response.

Automatic Control:

The VFD shall accept a 4 - 20 mA signal supplied from a process variable transducer, a PLC Controller, or a local Direct Digital Control (DDC) panel. The VFD control system, when in the "AUTOMATIC" mode, shall energize the motor when the Building Control System closes the enable contacts on the VFD. The motor shall be started in a controlled mode and ramped up to the speed called for by the process variable.

On a "STOP" command, the VFD will ramp the motor speed down under a controlled mode. The speed shall be infinitely varied between minimum speed and full rated speed either in direct proportion or inverse proportion to the signal from the process variable transducer, PLC Controller, or DDC panel in order to precisely match the application to the load. With nominal input power voltage and constant load, linearity and repeatability accuracy of the 3-phase outputs shall be within 1% of the process variable transducer's, PLC Controllers or DDC panel's control signal.

Manual Control:

The VFD shall be able to be operated in a manual mode that is independent of any process variable transducer, PLC Controller, or DDC control signal. In manual mode, the speed will be capable of being varied from 0 to 100% speed. This will be done from a control setting on the front panel as specified hereinafter. Manual control override shall not require any programming or interior modifications to VFD. Manual control shall be possible without stopping the drive, shutting down the system or modifying the unit operating parameters or reconfiguring system hardware.

The VFD shall include the following adjustable control functions:

Acceleration time adjustable from 1 to 60 sec

Deceleration time adjustable from 1 to 60 sec (separate control from the acceleration time adjustment)

Minimum motor speed adjustable from 0% to 100% of maximum motor RPM

Maximum motor speed adjustable from 80% to 100% of maximum motor RPM

Output frequency range adjustable from 3 to 60 Hz

Motor current limit adjustable from 30% to full rated motor current

Operator's Control Panel:

An operator’s control panel shall be mounted on each VFD compartment door and shall include the following devices in addition to any previously specified devices:

POWER ON indicating light

VFD RUNNING indicating light

VFD SHUTDOWN ALARM indicating light

Audible alarm that will sound anytime the VFD is locked out of operation. This shall also include a set of dry isolated form C contacts for remote alarming by the owner.

ALARM SILENCER push-button switch

VFD POWER DISCONNECT switch with external interlock operating handle

EXTERNAL FUSIBLE DISCONNECT switch that will drop all incoming power to the VFD without interrupting any other piece of equipment that might be tied to the same power supply; each unit shall include one 3 pole, 600 volt, quick- make, quick-break, manually operated switch connected in series with one replaceable dual element rejection type fuse per switch pole.

START/STOP push-button mounted in unit enclosure door and with unit start/stop control circuitry factory arranged and wired for local start/stop. Labeled terminals shall be factory furnished and wired for remote control circuitry wiring connections as indicated in wiring diagrams on drawings.

MANUAL/AUTO SELECTOR switch

Manual speed control potentiometer with linear calibration. This is used when the MANUAL/AUTO mode selector switch is in the "Manual" mode.

Digital indicator with linear calibration in percent of motor rated RPM. The digital speed display shall not require the use of a tachometer generator.

Digital indicator calibrated for percent of motor rated load current in amps. The digital indictor may be same as used for the percent speed indicator, but a SELECTOR switch must then be provided.

Control cabinet locking handle.

Bypass selector switch for selection of the VFD operation of the operation of across the line starter.

Provide following self-protection equipment and reliability features in all controls:

Limit-to-limit output current to 150% or inverter rating.

Current limit functions automatically preventing over-current trip due to momentary overload conditions; allowing inverter to continue operation.

Instantaneous over- current trip safely limits output current under 50 microseconds due to phase-to-phase short circuits or severe overload conditions, with shutdown as recommended by the equipment manufacturer.

Under-voltage trip protects inverter due to non-momentary power or phase loss, with shutdown as recommended by the equipment manufacturer.

Under-voltage trip activates automatically when line voltage drops 15% below rated input voltage.

Over-voltage trip protects inverter due to voltage levels in excess of its rating, with shutdown as recommended by the equipment manufacturer.

Over-voltage trip activates automatically when DC bus in controller exceeds 750 VDC.

Over-temperature trip protects inverter from elevated temperatures in excess of its rating.

When over-temperature trip point is reached in any section of the enclosure or in any section of the electronics in the VFD unit, a cabinet over-temperature light shall be continuously illuminated.

When over-temperature trip point is reached in the motor, a motor over-temperature light shall be continuously illuminated.

Automatic Reset/Restart:

When trip condition results from under-voltage, over-voltage or over-temperature, it automatically resets and inverter automatically restarts upon removal or correction of causative condition.

For safety and equipment protection, limit number of reset/restart attempts for to 3.

When in 3 attempts reset/restart is not successful, inverter shuts down safely, requiring manual restart.

When within 6 attempts successful reset/restart occurs, Auto Reset/Restart circuit reset attempts counted to 0 after approximately 2 minutes of continuous operation.

Short-Circuit Protection: In event of a phase-to-phase or phase-to-ground short circuit, control shuts down safely without component failure.

Power Interruption: When input or output power contactor is opened while control is activated, unit is not damaged.

Stand-Alone Operation: Provides for start-up, trouble-shooting, and operation of control without motor or any other equipment connected to inverter output.

START/STOP Control: Enables controller to be started or stopped by any of the following:

Contact closure

Use of motor starter or contactor in input power line

Speed control signal dropping below or rising above minimum

Minimum and Maximum Speed Adjustment Potentiometers:

Minimum speed adjustment potentiometer allows operating user to adjust minimum speed at which control will run motor from 0 to 25% when following 5000 ohm potentiometer.

Maximum speed adjustment potentiometer allows adjustment of maximum speed, at which control will run motor from 80 to 100% when following 5000 ohm potentiometer

Isolation of current and voltage signals from logic circuitry.

Drive Logic: Microprocessor based.

Dual-Safety Shut-Downs:

In event of sustained power loss, control shut down safely without component failure; on return of power system automatically returns to normal operation, when start is ON without forced deceleration and or drive fault.

In event of momentary power loss; control shuts down safely without component failure; on return of power system automatically returns to normal operation, when start is ON.

An adjustable time delay relay shall be used for restart after power failure and to provide time delay on "start" after "stop" control circuitry has been activated to prevent damage to the fan, motor or variable frequency drive unit. Time delay relay shall be solid-state type with a minimum range adjustment to 2 minutes delay after energization. Set delay time as recommended by the variable frequency drive unit manufacturer.

The variable frequency drive shall be protected from being restarted into a motor coasting in either the forward or reverse direction to protect the components of the VFD.

The VFD shall be protected from power line voltage transients resulting from the following:

Switching the primary of a line transformer

Energization or de-energization of contactors, relays, and other power equipment from the power line

Line-to-line or line-to-ground fault

Lightning

Notching from other VFDs or electronic switching power supply equipment

Solid state transient protection integral to the VFD shall be provided to a minimum of 10,000 volts and 50 joules without failure. The SCR's transistors and diodes located in the converter and inverter sections of the VFD shall have a minimum peak inverse voltage rating of 1,500 volts. Surge withstand capability of power input, power output and control signal inputs and outputs shall meet or exceed American National Standards Institutes (ANSI) standard C37.90-19-8 and Institute of Electrical and Electronic Engineers (IEEE) standard 472-1974 without failure. Failure is to be defined as loss of components in the VFD including power semi-conductors, logic components and/or fuses.

ACCESSORIES

Door mounted interlocked disconnect switch

Motor thermal overload protection with reset

HAND/OFF/AUTO switch; door mounted, with manual speed control potentiometer

Provide contacts for Building Control System can monitor position of HOA switch. (Reference drawings)

VFD/BYPASS switch; door mounted to allow operator to bypass controller and activate motor using bypass contacts.

Provide contacts for Building Control System can monitor position of switch. (Reference drawings)

Smoke mode interface with terminal strips and manual speed potentiometers.

execution

COORDINATION

Coordinate with Division 23 Contractor to ensure all power and control interlocks are provided and operational for complete operating system.

Provide electrical and control diagrams to affected contractors showing all interlocking wiring and control input locations.

INSTALLATION

The Contractor shall make installation as indicated on drawings and shall install wiring and make connections as indicted in wiring diagrams on contract drawings and in accordance with the manufacturer's approved shop drawings.

After installations are completed, the Contractor shall provide the services of the variable frequency drive unit manufacturer's service engineer for complete checkout, start-up, and adjustments for unit and to put unit into complete and proper operation Units shall not be energized or operated until checkout and put into operation by the service engineer. The motor shall be energized and operated through the variable frequency drive.

CAUTION: DO NOT ENERGIZE THE VARIABLE FREQUENCY DRIVE UNITS WITHOUT LOAD CONNECTIONS TO MOTORS BECAUSE IT COULD CAUSE MAJOR DAMAGE TO THE VARIABLE FREQUENCY UNIT.

Electrical Connections:

Ensure drive units are wired properly, with rotation in direction indicated, designed for proper fan performance.

Provide positive electrical equipment and motor grounding as per the latest NEC and as recommended by the VFD manufacturer.

As-Built Drawings:

The VFD unit manufacturer shall provide shop drawings for approval, which shall include complete description and specification data; complete wiring and connection diagrams for the units as furnished and as to be installed for this project, including control and power wiring as indicated in the wiring diagrams on the contract drawings; installation instruction; and instructions for operation, maintenance, servicing, and adjustments.

FIELD QUALITY CONTROL

After drive installation is complete, and after motor has been energized by factory trained technician, test each drive to demonstrate proper operation of unit at performance specifications.

When possible, field-correct malfunctioning units; then retest to demonstrate compliance.

START UP & SERVICE

Manufacturer shall provide factory-supervised start-up service for each drive specified.

Training:

The VFD manufacturer shall provide complete on-site training for the Owners Operating, Maintenance, and Engineering personnel. This training shall be a minimum of 2 days and shall include a complete description on the Theory of Operation, Operation Procedures, Functional and Operating Characteristics of Specific Logic Boards, Troubleshooting, Repair and Preventative Maintenance. A simulated failure is required to be diagnosed and repaired as part of this training.

Operations and Maintenance Manuals shall be provided and referenced during the instruction and training of the Owner's personnel.

Guarantee:

Each VFD unit shall be operated for a burn-in period of 100 hours minimum at the rated load and at the maximum ambient temperature in the unit manufacturer's plant prior to shipment.

The equipment shall be guaranteed free of defects and completely operational for a period of three (3) years from date of acceptance of equipment by the Owner. The guarantee shall be provided with two (2) years complete parts and labor coverage and one (1) year at 50% parts and labor coverage. The guarantee shall include all required labor including shipping and travel time.

END OF SECTION 262923

SECTION 263213 - DIESEL ENGINE ALTERNATORS

PART 1 -GENERAL

1.1 DESCRIPTION OF WORK

A. This section of the specifications includes the furnishing, installation, connection and testing of the diesel-engine alternator systems.

B. The engine alternator system shall be fully automatic and shall be complete and coordinated system ready for operation.

C. The engine alternator system specified herein shall be complete, including, but not limited to: diesel engine, lube-oil system, fuel oil system, cooling system, intake and exhaust system, starting system, alternator, control devices, wiring to interface with generator controls and supervisory systems as specified under other sections.

D. All equipment shall be new and of current production of the manufacturer of the engine alternator as an integral prime electric plant.

E. The manufacturer/package, together with its authorized representative, shall have full responsibility for the performance of the diesel engine-generator set, control equipment and its accessories.

1.2 SUBMITTALS

A. Shop Drawings and Product Data:

1) Submit shop drawings for the engine-generator to indicate all requirements of this Section. Submit shop drawings in accordance with Division 1, Section 01300.

2) Data shall be submitted in the following form:

a. Technical Data Sheets (TDS): These include published performance, rating and de-rating curves, published ratings, catalog cuts, pictures, manufacturer's specifications, material composition and gauge thickness, etc.

b. Description of operation (DO): Manufacturer's literature and, if suitable, diagrams.

c. Calculations (CALC): Detailed engineering calculations with all equations, graphs, assumptions, and approximations shown, and data sources referenced. Load study, Fault current study, coordination study, etc.

d. Certification (CERT): Written confirmation as to a document's accuracy, and genuineness.

e. Shop Drawings (SD): Scaled drawings showing dimensions, plan views, side views, elevations and cross sections

f. Diagrams (DGM): These include Control System diagrams, elementary diagrams, control sequence diagram or table, wiring diagrams, interconnection diagrams, wireless connection diagrams, illustrative diagrams, and flow diagrams, etc.

3) The following data shall be submitted to the Consultant for review prior to fabrication. For each engine-alternator set, and control and supervisory equipment:

a. Engine alternator set: TDS, SD, CALC

b. Engine jacket water heaters: TDS, SD.

c. Silencer assembly: TDS, SD

d. Torsional Vibration: CERT

e. Control and Supervisory Equipment: TDS, DGM, DO, SD. Submit a composite terminal to terminal diagram showing all controls, alarms, metering, etc.

f. Voltage regulating equipment, TDS, DGM

g. Frequency regulating equipment: TDS, DGM

h. Voltage and frequency dips and recovery times due to specified motor loading block loading: CACL, TDS, CERT

i. Attitude and Ambient de-rating: TDS

j. Fuel de-rating (i.e. Water White Kerosene vs. Diesel Fuel): TDS

k. High lift fuel pump: TDS, SD

l. Radiator: TDS, SD

m. All Flexible Hoses: TDS, SD

n. Engine mounted control cabinet (where provided): TDS, DO, SD, DGM.

o. Erection drawing of engine-generator set showing physical arrangement, mounting arrangement, location of vibration isolators, piping, fuel pump location inlets and outlets, valves, temperature and speed sensors, electrical work, etc; minimum scale 1/2” = 1’-0”.

p. Engine horse power curves of the engine rating for prime power application based on actual testing of a similar package. Special ratings or “maximum” ratings will not be acceptable.

B. Certifications:

1) Certify in writing that a diesel engine of the same model with the same bore, stroke, number of cylinders, same turbocharger arrangement, configuration and equal or higher BMEP and RPM ratings as the proposed diesel engine has been operated satisfactorily, with connected loads of not less than 75% of the specified KW/KVA rating, for not less than 2,000 hours without any failure of a crankshaft, camshaft, piston, valve, injector or governor system.

2) Certify in writing that devices and circuits will be incorporated to protect the voltage regulator and other components of the auxiliary electrical power system during operation of the diesel engine-alternator set at speeds other than the rated RPM while performing maintenance. Include thorough descriptions with submittals of any precautions which will be necessary to protect the voltage regulator and all other components of the system during operation of the diesel engine-alternator set at speeds other than the rated RPM.

3) Furnish system free of injurious torsional and bending vibrations within entire speed range from 0 to 125% of synchronous speed. Submit prototype certification of vibration analysis.

4) Factory Test Report: Submit certified test reports, strip chart recordings of load, ambient temperature, water temperature (inlet and outlet) and photographs showing test set-up and equipment.

C. Operation and Maintenance Manuals:

1) Submit three (3) complete legible operating and maintenance manuals for the engine-alternator set and auxiliaries including wiring diagrams, technical data sheets and information for ordering replaceable parts.

2) Diagrams:

a. Include complete interconnection diagrams which indicate all components of the system.

b. Include complete diagrams of the internal wiring for each of the items of equipment.

c. The diagrams shall have their terminals identified to facilitate installations, operation and maintenance.

3) Maintenance Data:

a. Furnish copies of complete lists of the spare parts and special tools recommended for two years of normal operation of the complete system including the manufacturer's names, addresses, catalog numbers and prices.

4) Operating Instructions Submittal Required:

a. Manufacturer's operating instructions for each item of equipment furnished

b. Supplemental with additional specific application instructions where necessary

c. Specific operating instructions for each portion of system which involves multiple items of equipment

d. Instructions for charging, start-up, control or sequencing of operation, phase of seasonal variations, shut-down, safety and similar operations; typewritten in completely explained and easily understood English language.

5) Maintenance Manual Requirements:

a. Emergency instructions including addresses and telephone numbers for service sources

b. Regular system periodic maintenance procedures

c. Proper use of tools and accessories

d. Wiring and control diagram for each system

e. Manufacturer's maintenance data recommendations and procedures including complete parts lists, exploded views, etc. for each operational item in each system.

f. Manufacturer's product warranties and guarantees relating to the system and equipment items in the system

g. Shop drawings related to the system

h. Bind each operating and maintenance manual in one or more vinyl-covered, 2", 3-ring binders, plus pocket-folders for folded drawings. Index with them tab for sections

i. Mark the back spine and front cover of each binder with system identification and volume number.

6) Spare Parts: Furnish as a minimum, the following spare parts. Where more than one engine is furnished, provide one complete set of spare parts for multiples of two engines.

a. Provide one complete set each of lubricating oil filters, hoses, fuel oil filters, air filters, radiator belts, governor control and actuator, voltage regulator, control modules including speed switch assembly, and three (3) each of any relays used.

b. Provide one (1) time delay relay of each type; one set of fuses each size, one circuit breaker each size and one set of indicating lamps for battery charger.

c. Provide one set of spare microprocessor cards for all functions including engine control module, onset engine start and control panel, etc.

1.3 JOB CONDITIONS

A. Space: Shall conform to the arrangements and details shown on the drawings and to the spaces designated for their installation. The dimensions, enclosures and arrangements shall permit the operating personnel to safely and conveniently operate and maintain the system in the space designated for installation.

B. Unless specified otherwise, each component of the engine-alternator system shall be capable of operating as specified herein at 0-1500 feet above sea level in a ventilated room which will have an average ambient air temperature ranging from a minimum of -20°F. in winter to maximum of 120°F, and 90% RH in summer.

1.4 STANDARDS

A. The following specifications and standards, except as hereinafter modified, are incorporated herein by reference and form a part of this specification to the extent indicated by the references thereto. Except where a specific date is given, the issue in effect (including amendments, addenda, revisions, supplements, and errata) on the date of Invitation for Bids shall be applicable. In text such specifications and standards are referred to by basic designation only.

1) National Fire Protection Association (NFPA) Publications:

a. No. 70 National Electrical Code (NEC)

b. No. 37 Stationary Internal Combustion Engine

2) Underwriter's Laboratories, Inc. (UL) Publications:

a. No. 508 Electric Industrial Control Equipment

b. No. 891 Dead-Front Electrical Switchboards

c. No. 50 Cabinets and Boxes

3) National Electrical Manufacturers Association (NEMA) Publications:

a. ICS Industrial Control and Systems

b. IS4 Terminal Blocks for Industrial Control Equipment

c. II2 Electrical Indicating Instrument - Relay

d. MG1 Motors and Generators

e. MG2 Safety Standard for Construction and Guide for Selection Installation and Use of Electric Motors and Generators

4) American National Standards Institute (ANSI) Publications:

a. C37.90a . . . IEEE Guide for Surge Withstand Capability (SWC) Test

5) Engine Standards

a. SAE 1349

b. ISO 8528, Part 2

c. EGSA 101P

d. IEEE 446-1987 (Prime application)

6) FM Global Standards for Construction

1.5 WARRANTY

A. The Engine-Generator shall be guaranteed by the manufacturer against defects in material and workmanship for a period of two (2) years or 1000 running hours from date of acceptance by BIVI. Warranty shall include parts and labor at the site of the work.

1.6 SEISMIC REQUIREMENTS

A. This engine-generator(s) is located in a seismic zone 0. Engine-generator(s) shall be constructed with all necessary bracing required for installation in specified seismic zone.

PART 2 -PRODUCTS

2.1 GENERAL

A. Published Rating:

1) Shall be not less than 100/125 KW/KVA at 277/480 volts, 3-phase, 4-wire, 60 Hz, 0.80 power factor.

2) The set shall be rated for standby power as defined by NEMA and EGSA standards, and all shall meet all other requirements specified herein.

B. Coordinate the components of the system and their arrangements electrically and mechanically.

C. Connections between components of the system shall conform to the recommendations of the manufacturer of the diesel engine-alternator set.

D. Couplings, shafts, fans, gears and other moving parts shall be enclosed and guarded. Guards shall be metal, ruggedly constructed, rigidly fastened and readily removable for convenient servicing of the equipment without disassembling any pipes and fittings.

E. Protect the diesel engine and its water cooling system at all times against freezing weather conditions.

F. The Engine/generator system to be free of injurious torsional and bending vibrations within entire speed range from 0 to 125% of synchronous speed

G. The Engine-Generator system shall be capable of operating satisfactorily at rated capacity as specified for not less than 10,000 hours between major overhauls.

H. Where reasonable uncertainty exists regarding the adequacy of the diesel engine-alternator set the contractor shall perform additional tests to verify or modify the submitted data at no additional cost to BIVI.

I. Acceptable Engine/generator manufacturers:

1) MTU

2) Kohler

3) Generac

4) Cummins

5) Caterpillar

2.2 DIESEL ENGINE

A. The diesel-engine shall be general purpose, industrial, diesel, solid injection, water cooled, two or four cycle, compression ignition type. Engine may be naturally aspirated, scavenged or pressure charged. Scavenger units or pressure chargers shall be quiet under full load operating conditions. Provide rated net horsepower at generator synchronous speed, with all accessories attached required to produce KW specified, taking into account generator efficiency.

B. Minimum brake horsepower - 150 HP at SAE standard conditions

C. Operating speed shall be 1800 RPM

D. The engine shall start cold in a 40 degree F ambient while using Water White Kerosene without the use of starting aids such as glow plugs and ether injections. Specified horsepower and KW shall be obtained using DF-2 diesel fuel

2.3 GOVERNOR

A. Use electronic controlled governor with electric actuator. Electronic type governors shall employ separate, isolated magnetic pick-up for frequency sensing.

B. Governor to provide isochronous speed control and proportional load sharing adjustment for use with paralleled engines and interface with Generator Control Panels.

C. Speed Control:

1) Stability: plus or minus 0.25% maximum frequency variation at any constant load from no load to full load.

2) Regulation: plus or minus 0.25% maximum frequency deviation between no-load steady state, to full load steady state.

3) Transient: 3.5% maximum frequency rise on one-step removal of 0.8 P.F. full load; maximum recovery time to 1800 RPM - (2.8) seconds.

4) Transient: 12.8% maximum frequency dips on block loading of 100% of unit rating with maximum 2.6 second recovery time.

D. Provide certified prototype response curves for engine with specified generator, governor, etc.

E. Mount governor controller in associated Engine Control Cubicle, specified under other sections.

F. Provide manual speed adjusting control with remote speed control switch mounted on engine control panel.

G. Do not use governor for overspeed shutdown control and alarm.

H. Governor shall be modified as necessary by manufacturer for proper operation with engine dynamics. Actuator shall have proper torque to provide proper operation over entire dynamic speed range.

I. Acceptable governor manufacturers shall be:

1) Woodward 2301A (24VDC)

2.4 LUBRICATION OIL SYSTEM

A. Provide a pressurized lube oil system with built-in, engine driven, geared, positive-displacement type pump.

B. Provide full-flow strainer and full-flow duplex oil filter, with automatic by-pass and secondary filter.

C. Filters shall be spin-on, replaceable type and shall remove particles as small as 12 microns without removing the additives in oil.

D. Provide an extended lube oil sump drain line passing out through the base. Terminate this line with a drain valve, and end capfitting (hose connectable).

E. Provide bayonet level gage. Oil sump shall be quiet (non-pressurized) and oil level monitoring shall be accessible while engine is running without any blow back. Fill engine oil sumps before acceptance testing.

2.5 ENGINE FUEL OIL SYSTEM

A. Provide injector pump(s) and nozzles to provide minimum horsepower specified.

B. Plungers shall be carefully lapped for precision fit and shall not require any packing.

C. Do not use filters or screens which require cleaning or replacement in the injection system assemblies.

D. Return surplus fuel from the injectors to the main storage tank

E. Engine fuel pump shall be positive displacement high lift pump capable of delivering proper fuel quantity and pressure to injectors for installation as shown.

F. Filter system:

1) Fuel filter shall be of a replaceable element type and shall entrap and remove water from fuel oil. Primary filters shall be RACOR Model 75/1000 FG, dual element, 30 micron, 6.32 gpm, with service valves, vacuum gage and water sensor probes and with remote LAD-T/M - 24V gage and alarm mounted in engine control panel. Mount filters on engine rail near radiator and fuel inlet pipe connection.

2) Provide manufacturers standard secondary spin on type filters (engine mounted) located so the fuel oil will be thoroughly filtered before it reaches the injection system assemblies.

G. Provide valved, hand operated fuel-oil priming pump mounted on the engine as an integral part of the fuel system. Valves shall be stainless steel ball valves. Priming pump shall be Gorman Rupp Model HO3/4A4-H or accepted equivalent option is acceptable.

H. Provide a fuel cup on the pressure side of the engine fuel pump and on the vacuum side of the injector pump. Provide a small valve for sampling fuel.

2.6 JACKET WATER COOLING SYSTEM, AND RADIATOR HEAT DISSIPATION

A. Engine mounted radiator.

1) Engine to be liquid cooled with engine mounted, air cooled radiator and engine driven fan.

2) Cooling liquid to circulate through engine block, inter-cooler, oil cooler, etc., as required to completely cool engine system.

3) The engine shall discharge water to air cooled radiator by centrifugal, engine driven pump(s). Provide pressure relief devices as required to prevent excessive pressure increase after engine stops.

4) Radiator capacity and cooling characteristics shall be designed to cool engine discharge liquid adequately for an engine to carry rated load with 120°F ambient air at the radiator intake and 0.5" H_20 fan backpressure.

5) The radiator shall be mounted to the common engine sub-base, with its fan belt driven from the engine crankshaft. The belting design shall consist of a multi-belt design such that if one belt breaks, the remaining belts shall be capable of operating the engine at its operating speed for an indefinite period.

6) The fan bearings shall be pre-packed with grease and require no additional lubrication for a period of five (5) years or 10,000 hours of operation.

7) The radiator shall be copper or brass casing with copper fins with properly sized expansion tank of same material built into its header.

8) The fan shall be of the pusher type, i.e., the air shall be blown through the radiator.

9) The lowest points in the water jacket shall be equipped with drains piped to the engine rail and provided with a ball valve with hose connector so that all coolant may be drained from the engine and radiator.

10) A radiator duct ledge adapter shall be provided to connect to the exhaust plenum.

B. Provide Engine block Electric heaters, for maintaining the engine coolant temperature at the temperature recommended by the manufacturer of the engine. The temperature should not exceed 140°F. Low Ambient temperature is -2°F.

1) Install thermostatic controls, oil pressure switch and contactors as required to control heaters

2) Heaters to operate continuously except while the engine is operating or the water temperature is above 140°F; provide a minimum of 3000KW (or larger as required by manufacturer) 208 V, 1 PH. heaters, one on each side of engine.

3) Provide isolation valves (2 each heater) on heater connections to allow removal of heater without losing coolant. Valves to be stainless steel ball valves same size as coolant piping to heater.

4) Pre-wire heaters and controls to engine control terminal box.

C. Provide engine thermostat with pump bypass to allow engine to warm up quickly.

D. All main radiator water piping interconnections shall be braided stainless steel or reinforced silicon rubber hose with double heavy bracket type circle clamps or approved equivalent at each connection. Do not use standard hose clamps. All other hose shall be heavy hydraulic hose as specified herein.

E. Provide coolant level alarm switches equal to Murphy "Switchgage" with manual test actuator, to provide pre-alarm and shutdown alarm as described herein; shutdown alarm to initiate after loss of 30% of coolant.

F. Furnish engine coolant with ethylene-glycol diesel rated coolant with inhibitor (Nalcool or accepted equivalent) to prevent freezing to temperature of -20 degree F. (Approximately 50% solution). Provide specific gravity test and corresponding protection temperature in maintenance manual.

G. Provide a coolant recovery system to prevent loss of coolant. Provide a pump to manually reinstall coolant into radiator.

2.7 EXHAUST SYSTEMS

A. Use engine-mounted turbochargers driven by the engine gases, securely braced against vibration and adequately lubricated by the engine's filtered lubrication system.

B. The exhaust gas emission shall comply with all Federal, State, and Local Emission Codes in force at the location. Information on the content and capacity of exhaust gases emitted by the proposed engine at 25%, 50%, 75% and full loads shall be included in shop drawings.

C. Exhaust Silencer shall be: Welded steel and chambered, Joints shall withstand 5 psi air test; rated for Residential grade silencing. Comply with all local ambient noise requirements. Provide outlet locations as required to have silencer fit in enclosure. Silencer rated for 1100 F°.

D. Pressure drop in the complete exhaust system shall be small enough for satisfactory operation of the engine-alternator set while it is delivering 100 percent of its specified rating.

E. Manufacturer shall submit a backpressure calculation for the piping and silencer system to verify proper operation with system designed and shown on drawings.

F. Provide a short (18" long maximum) flexible 300 series stainless steel exhaust section with 125 psi flange type connections installed as close as possible to engine exhaust manifold to isolate engine from the rigid exhaust piping. Provide wye connector in combination with flexible connectors where exhaust manifolds are split with two engine outlets. Provide a 1/2” tap near the exhaust connector to measure the back pressure of the installed system.

G. All hardware for exhaust system rated 1100 F° including nuts, bolts, washers, gasket materials, blankets, etc. Use 300 series stainless steel bolts, nuts and washers as required to meet temperature requirement.

Battery Rack: All racks shall provide for total visibility and access, and shall be fabricated with pre-cut slots for anchoring. Provide battery restraints for UBC Seismic Zone 2A Metallic battery racks shall be grounded.

Warranty: For float/stand-by service applications the battery manufacturer shall provide a written 5 year 100% performance guarantee followed by a 15 year prorated warranty totaling 20 years.

Provide battery charger to maintain batteries at full charge.

Charger to operate from normal power source. Charger to recharge 100% duty cycle discharge in eight (8) hours on high rate, 10 ampere DC minimum. Submit calculation for charger with shop drawings.

Furnish automatic high and low rate (float) charger equalization circuit. Provide manual high rate switch and 24 hour equalize timer.

AC Power on open green LED.

High rate charge amber LED.

Fused AC input and DC output.

Provide ammeter to indicate charge rate.

Provide voltmeter to indicate battery voltage.

High voltage alarm and red LED.

Low voltage alarm and red LED.

Float charge indicator green LED

Designed to prevent damage during engine cranking (cranking circuit disconnect relay where required).

Provide with D.C. failure relay and red LED.

A.C. input failure relay (time delay on dropout, adjustable 0-60 seconds, set at 30 seconds) for connection to alarm annunciator and red LED.

Rectifier fail relay and red LED.

2.8 MISCELLANEOUS ENGINE PROVISIONS

A. Provide an engine mounted instrument board with following equipment properly connected for service and identified with permanent marking:

1) Pressure gage - fuel header

2) Pressure gage - lubricating oil

3) Temperature gages - coolant inlet and outlet. (Two (2) required)

4) Temperature gage - lubricating oil

5) Air restriction gage for air filters

6) Emergency stop switch connected to air box damper and/or engine controls as specified

7) Running time meter and digital tachometer (0 - 125% rated speed), 4" diameter

8) All gages shall be 2% accuracy (within normal operating range) analog, 2-1/2" diameter (except as noted), with engine normal operating range permanently red lined on each gage

9) Ammeter, voltmeter, frequency, KW and PF

B. Provide an engine terminal box for connection of all external power, control and monitor leads terminated in a terminal block. Each conductor shall be identified with permanent PVC or vinyl markers equal to T&B type WSL self laminating. Terminal blocks shall also be identified with permanent marking.

C. Provide exhaust manifold with drilled and tapped holes for exhaust pyrometer (plugged) and covered with 2" thick, 8 pound density, 1200°F. insulating blanket, Hitco or accepted equivalent. Provide blanket with eyelets and sew blankets to engine with high temperature glass cord.

D. Provide industrial grade, metal enclosed air cleaner: Size and type as recommended by engine manufacturer. Provide connections and sensor for air restriction gage. Air cleaner elements shall use replaceable dry elements. Special tools shall not be required.

E. Provide manual reset electric emergency shutdown using air box damper where available as option from manufacturer, for use with remote emergency stop switches to shut down engine. Provide alternative electrically operated positive shutdown means if air box damper is not available. Do not use emergency shutoff for normal engine shutdown functions.

F. All flexible piping installed on the engine by the manufacturer, packager for lube oil, fuel oil and water shall be heavy wall hydraulic hoses rated 300 psi. Connect with hydraulic crimp type, screw pattern connectors. Temperature rating of hose and connectors shall be 50°F higher than the highest expected temperature of the fluid carried by the pipe.

2.9 ALTERNATOR (Low Voltage)

A. The alternator shall be synchronous, self-ventilated, drip proof construction, single-bearing rotating-field type with PMG pilot exciter or series boost exciter connected directly to the engine. Provide flexible type coupling connection to engine to prevent accidental damage of engine or alternator shaft for positive alignment.

B. The alternator shall be designed for convenient connection to and removal from the engine. Provide lifting eye(s).

C. The alternator windings shall be copper, designed for good wave shape and low noise level. Output shall not deviate from standard sine waveform more than +5%. Telephone influence factor (TIF) shall be less than 50 based on 1961 weighting curve. The alternator open circuit terminal voltage deviation factor shall not exceed 0.06.

D. The deviation factor for the alternator open circuit voltage shall not exceed 6% as determined by IEEE Test Code 503.

E. Provide amortisseur windings integral with the rotor coil support.

F. The alternator winding pitch shall be the standard of the manufacturer, but not less than 2/3, all generators to have same pitch. Submit generated harmonic analysis for 3rd, 5th, 7th, 9th and 11th harmonics; no single harmonic shall exceed 3%, and the total harmonic content shall not exceed 5% THD, line-to-line or line-to-neutral. Where alternators are connected in parallel with other alternators, all alternator winding pitches shall be the same.

G. Winding insulation Class F with maximum winding temperature rise of 105°C above 40°C ambient and altitudes of up to 1500 feet; submit de-rating data for altitudes above 1500 feet. Basic Impulse Rating (BIL) of insulation shall be 7.5 KV minimum.

H. Winding insulation system shall utilize a heavy film insulation material. After completion of the coil winding insulation process, the entire coil assemblies shall be vacuum pressure impregnated with thixotropic epoxy resin designed for good bonding quality, slot fill, and winding rigidity to produce a void free insulation system. Insulation and mechanical parts shall have minimum 10,000 hour life at full load. Insulation shall have 30 year shelf life minimum.

I. Alternator rated 600 KW at 0.8 power factor, 750 KVA, 277/480 volts, 3 phase, 4 wire, 60 hertz, (wye) delta connected, 12 lead re-luggable to all winding configurations, for application of different voltages as shown. Alternator capable of 150% overload for one (1) minutes without damage.

J. Alternator shall withstand short circuit currents (phase to phase, 3 phase, or phase to neutral) in conformance with NEMA Standards without damage to alternator. Alternator shall be designed to deliver 300% current for 10 seconds without damage. The alternator short circuit capability shall meet the requirements of ANSI C50.10 and NEMA MG-1.

K. Provide closely applied MOV surge arresters as recommended by generator manufacturer. to protect generator from lightning and/or switching surges. Mount arresters in terminal connection box.

L. Alternator shall withstand 125 percent of the RPM specified for the set without damage. Submit certification.

M. Alternator bearings shall be the shielded type with a minimum designed L-10 service life.

N. Efficiency shall be not less than 95 percent for entire load range.

O. In addition to any requirements of the NEC: Nameplates attached to the generator and exciter to show manufacturer's name, equipment identification, serial number, voltage ratings, field current ratings, KW/KVA output ratings, power factor rating, time rating, temperature rise ratings, RPM ratings, full load current rating, number of phase and frequency, and any field connection and multiple storage requirements.

P. Alternator shall be complete with terminal box with properly sized and braced bus bars with provisions for cross current regulator CT, regulator current limit CT's, differential CT's and adequate space for proper cable terminations. All exposed terminals and wiring shall be insulated with 600 volt heat shrink insulation material as manufactured by Raychem.

Q. Acceptable Generator Manufacturers:

1) Cummins DQCA

2) Caterpillar

3) Kohler

2.10 VOLTAGE REGULATOR

A. Provide solid state volts per Hertz voltage regulator powered from the PMG pilot exciter to maintain voltage within limits as specified below:

1) Stability: +2.0% maximum voltage variation at any constant load from no load to full load, including a ±2-1/2% frequency deviation.

2) Regulation: +2.0% maximum voltage deviation between no-load steady state and full-load steady state, including a ±2-1/2% frequency deviation.

3) Transient: 20% maximum voltage dip on one-step application of 0.8 power factor 100% load with a recovery time of less than 7.0 seconds.

4) Transient: 25% maximum voltage dip on sequential loading in 33% (assume 33% of set rating) with 25% pre-load). Recovery time shall be less than 4.0 seconds or 60% of each step time interval whichever is less.

5) Transient: 2.5 seconds maximum voltage recovery time with removal of 0.8 power factor full load.

B. Regulator to be 3 phase sensing with regulator current limit control with necessary current transformer etc., to prevent regulator runaway.

C. Provide connections for remote voltage adjustment (motorized potentiometer as required installed in Generator Control Panel). Minimum range of adjustment at no load and 60 hertz, shall be + 10%.

D. Regulator-generator system with necessary devices to restrict the radio interference to limits of military specifications STD-461A.

E. Acceptable regulator manufacturers:

1) Basler

2) Caterpillar

3) Cummins/Onan

4) Kohler

2.11 ALARM AND SHUTDOWN MONITORS

A. The repetitive accuracy of the parameter monitors shall not exceed the following limits:

1) Voltage Monitors + 2% of set point

2) Current Monitors + 3% of set point

3) Frequency and Speed Monitors + 0.2 Hz

4) Power Monitors + 3% of set point

5) Temperature Monitors + 3% of set point

6) Repetitive accuracy's shall be as stated over an environmental temperature range of 0 degrees C to 50 degrees C and voltage range of 70% to 110% of nominal. Overspeed monitor shall trip at 115% maximum.

B. All monitors and sensors shall be calibrated before specified field testing.

C. Provide monitors as required to provide monitor and shutdown functions described in this Section.

2.12 ENGINE MOUNTING

A. Mount engine, radiator and generator on steel beams, size as required, to prevent excessive flexing and vibration between components. Submit torsional analysis for review.

B. Provide cast semi-steel(spring type) vibration isolators between generator mounting beam and floor slab as required to damp 97% of Generator set vibration. Isolators shall have fully adjustable snubbers and synthetic rubber snubber inserts. Provide internal leveling adjustment. Base of isolator provide with sound pad. Vibration isolators shall be Korfund Type LIE or accepted equivalent. Provide mounting top bolt arrangement as required to allow bolting to generator beam.

C. Provide springs, restraints, and snubbers as required to meet requirements of Seismic zone specified herein for inside installations only.

D. Acceptable Vibration Isolator Manufacturers:

a. Korfund

b. ACE Mountings

c. Kinetics

2.13 PAINT

A. Entire engine-generator assembly shall be painted with two (2) coats manufacturer's standard color after fabrication is complete.

2.14 ENGINE CONTROL AND POWER WIRING

A. All control and power wiring shall be rated for temperature to which it is exposed, but rated not less than 105°C, and color coded or numbered and bundled.

B. Color Code:

1) White - CT Leads

2) Blue - DC Control

3) Red - AC Control

4) Yellow - AC Power

5) Green - Ground

C. All wiring connections made with insulated, long barrel, locking fork compression, dual crimp type terminals, T&B "Stakon" or accepted equivalent.

D. Each wire shall be identified with permanent PVC or vinyl wire markers T&B type WSL self laminating or accepted equivalent at every break, (i.e. terminal strip, relay, control device, etc.). All terminals shall be permanently identified with vinyl or Bakelite markers. All devices shall be identified with Bakelite nameplates located in readable location and fastened with screws.

E. Provide grounding lug plates on each side of engine rails and one 1/4" x 4" ground bus in the terminal box pre-drilled for standard 2-hole compression lugs.

F. The manufacturer shall coordinate the interfacing of the engine mounted controls system with all related equipment supplied in accordance with other sections of the project.

2.15 SIGNAGE

A. Provide signage on engine required for proper operation and any code required signage where danger exists. In addition, provide a sign on the rear of each engine-generator indicating the engine-generator number reference and that unit is auto start. Signage shall have 2" high letters reading "GEN 007, DANGER - AUTOMATIC START".

2.16 outdoor engine enclosure

A. The enclosure shall be non walk-in, designed to provide weather resistance and easy maintenance of the generator set. Enclosure designed for 150 MPH wind load minimum.

B. Enclosure shall be weatherproof with exhaust silencer. Average overall sound power level shall not exceed 72 db(A) @ 25 feet.

C. Enclosure designed to sit on engine subbase fuel tank.

D. A minimum of (5) rigid hinged doors and/or louvers shall be provided. The interior of the enclosure shall be designed to permit normal maintenance of the generator set without enclosure removal. For extraordinary maintenance, the enclosure shall be designed with lifting rings and anchor fittings to permit lift off removal of the enclosure.

E. The enclosure strength members shall be constructed of ASTM A36 steel. Joining of the various strength members shall be done by welding. Mechanical fasteners are not acceptable and shall not be allowed. Each structural member shall be primed and painted with a high grade primer and two (2) coats of an automotive type black enamel. Provide additional bracing as required to comply with Seismic zone specified herein.

F. The exterior surface of the enclosure and accesses shall be manufactured of 14 GA. (.063 in.) white baked enamel finish aluminum panels. The panels shall be formed and joined without the use of exposed rivets or fasteners on the exterior vertical surfaces of the enclosure when assembled. All exterior panels of the roof shall be weather sealed using a 100% silicone compound and covered by a white baked enamel 14 GA. aluminum strip attached using self sealing mechanical fasteners. The exterior top and bottom perimeter of the enclosure shall be protected by 3” wide by 0.25” thick aluminum rub rails. These rub rails shall be placed on top of silicone sealer and attached using self sealing mechanical fasteners. The enclosure shall be designed to withstand a 4”/hr. rain test.

G. Air intake shall be via a fixed louver system of sufficient size to allow proper cooling and combustion air flow as specified by the generator manufacturer with maximum velocity of 1000 ft. per minute. Air exhaust from radiator shall be via a louver, and gravity closed backdraft damper. Provide 10 gage 1/2” x 1/2” aluminum wire bird screen on interior of all fixed louvers.

H. All hardware for doors, muffler supports, and roof penetrations shall be 300 series stainless steel.

I. In addition to the genset, internal equipment and device requirements include, but are not limited to, the following:

1) Main Generator Breaker

2) Battery Charger

3) Engine Jacket Water Heaters

Three (3) 120 V, 2 lamp, 4’, vaportight fluorescent AC lights with on/off switch

Two (2) Work Receptacles (20A, 125V, 2P, 3W: GFCI type)

J. At any point where the frame and surface panels are designed to touch, a gasket of sufficient type and size shall be permanently affixed to prevent dissimilar (bimetallic) corrosion.

K. The roof frame shall be designed to have sufficient structural bracing to support those components (i.e. silencers, etc.) scheduled to be placed on or supported by the roof. Walk-in enclosure roofs shall be capable of supporting 50 lbs/sq. ft. minimum. The roof shall be designed with sufficient chamber or pitch to permit normal water, snow and ice shedding.

L. The electrical package shall ensure that suitable lighting, light switches, and convenience receptacles are wired and operate properly. Submit layout, circuit design, etc., for review. All electrical components shall be UL listed and installed in accordance with the 2005 National Electric Code and all local ordinances.

M. Acceptable Enclosure Manufacturers:

1) Cummins/Onan.

2) Caterpillar

2.17 FUEL TANK (SUBBASE)

A. A UL Listed, closed top, diked skid base fuel tank shall be provided. Tank capacity shall be adequate to operate generator at full load for 24 hours minimum.

1) Base tank shall have continuously welded seams and formed steel channel type side beams. The tank shall be capable of supporting the weight of the generator and enclosure.

2) Internal baffles shall be provide to prevent recirculation of heated return fuel.

3) The tank shall be provided with the following options.

a. 2” brass filler cap

b. Mechanical fuel gage

c. Primary vent with breather

d. Venting areas to UL 142 specifications

e. Leak detection sensor connected to alarm panel

f. Emergency vent for main tank

g. Weather proof diked containment basin

h. External NPT drain fittings for fuel tank and containment basin

i. Removable base end cover plate to allow access to stub-up area for main power conductors

j. Integral lifting points

k. Electronic fuel level sensor

Remote annunciator

Provide a Universal Annunciator with visual and audible warnings of up to 20 separate alarm or status conditions.

PART 3 -EXECUTION

3.1 Factory Test

A. The Owner and Engineer shall have the option of witnessing the following tests at the factory. All expenses for Owner's representative trip to witness these tests will be paid by the Owner/Engineer. Notify the Owner/Engineer 15 days prior to day of testing. Furnish load banks, fuel, transformers, starting battery, testing instruments and all other equipment as necessary to perform these tests.

1) Load Test: Shall include minimum of four (4) hours of continuous operation for each engine-generator while the set is delivering 100 percent of specified KW with 0.8 Power factor at 105°F ambient temperature. During this test, record the following data at 15-minute intervals:

a. Time

b. RPM

c. Fuel Pressure

d. KW Output

e. Water Temperature In

f. Oil Pressure

g. Output Voltage

h. Water Temperature Out

i. Ambient Temperature

j. Amperes

k. Oil Temperature

l. Inlet Air Temperature at Radiator

2) Test all engines and alternator safeties, and calibrate prior to test.

3) Quick Start Test: Record time required for the engine alternator set to develop specified voltage, frequency and kw load from a cold standstill condition.

4) Block Loading Test: 50%, 75% and 100% of full load, with measured response.

5) Sequential Loading Tests: 33% steps to full load with measured response.

6) Provide recording voltage and frequency analyzer acceptable to Owner/Consultant to measure and record all tests. The following accuracy is required:

a. Output voltage, line-to-line on each phase, measured to an accuracy of +/- 1.0 percent

b. Output current, each phase measured to an accuracy of +/- 1.0 percent

c. Output KW, measured to an accuracy of +/- 2.0 percent

d. Coolant temperature, to an accuracy of +.-1.0°F.

e. Oil pressure, to an accuracy of +/- 1.0 percent

f. RPM of generator or frequency of output to an accuracy of +.- 3 RPM or +/- 0.1 Hz, respectively

g. Fuel pump pressure, to an accuracy of +.- 1.0 psi

h. Ambient temperature, accuracy +/- 1.0°F

i. Time meter, accuracy +/- minute

j. Barometric pressure, accuracy +/- 1.0" Hg

7) Provide certified copy of all test sheets to the Owner at the completion of tests.

3.2 INSTALLATION

A. Install engine-generator on vibration isolators on isolated concrete pad as shown on drawings. Bolt isolators to pad. Bolt top isolator pad to engine rail. Adjust isolator dampers.

B. Connect all fuel, exhaust, air, lube oil, cooling system, batteries and chargers, ventilation, and lube equipment for complete proper operation of engine and generator.

3.3 ENGINE-GENERATOR FIELD LOAD TEST

A. Conduct field load test on each new engine-generator supervised by manufacturer, BIVI's representative and design consultant. Eight hours of continuous operation with 1/2 hour at 50% load, 1/2 hour at 75% load and 7 hours at 100% of the generator KW load rating at rated voltage and frequency.

B. Verify all engine generator control functions, alarms, (remote and local), and all safety shutdowns and pre-alarms.

C. Conduct test at 95°F. ambient temperature minimum (as near as practical) demonstrating specified load carrying capacity without overheating.

D. Furnish load testing load banks and apparatus, step down transformers, connections, room heaters, etc., for tests. Provide instrumentation to record room ambient temperature, intake air temperature, and radiator ambient air temperature during load test.

E. Record all quantities, temperatures, etc. same as factory test above. Also record exhaust back pressure, battery charger voltage and current and any fluid leaks. Recording instruments same as described above for factory tests.

F. Repeat quick start and block load tests same as factory test specified above.

G. If the tests are stopped for any reason, repeat entire 8-hour test until satisfactory results are obtained.

H. The Contractor shall furnish diesel fuel for tests and start up.

I. Owner/Consultant to witness tests. Two weeks' notice required.

J. After the generators have been load bank tested, perform a complete emergency system load test with available system load for a minimum of 2 hours continuous.

K. Perform all tests at rated voltage and frequency.

L. All tests shall be reported by the manufacturer's representative and furnished to BIVI at the conclusion of the testing. Provide a typed copy of the test reports to BIVI within 5 working days.

3.4 RECORDING GENERATOR SET QUALIFICATION AND PERFORMANCE TESTING

A. The following procedures shall be utilized in the Qualification and Load Testing of the Generator Set, Control Panel, and Transfer Switch at the site after the installation is complete. Tests are described above.

B. General:

1) Testing procedures which are included, or attached, incorporate the standard methods, required for the qualification and performance testing of the engine-generator set(s) and control(s) installed.

2) Resistance load bank testing shall be continuous 8 hour load testing as specified herein.

3) Testing procedures are valid and approved, only for testing conducted in accordance with this document and, using the standard load banks and testing equipment approved for this purpose.

4) Testing will be witnessed by a representative of BIVI or Consultant's or both who will review all test results. The Contractor or their representative or both shall witness these tests, document and certify the results.

5) Testing of all equipment will be under the direction of the generator manufacturer and Owner's Representative. During periods of actual performance and load bank testing of equipment, all personnel witnessing the tests will be under the direction and supervision of the Contractor who will be responsible for the performance of all tests. Any person not adhering to safety directives will be required to leave the testing area or all testing may be halted or both.

6) In addition to the listed testing procedures, copies of the attached test logs are to be completed by the Contractor with all test data, and the original of the test logs shall remain in Owner's or Consultant's property before, during and after each test.

7) Any discrepancies, failures or problems encountered are to be reported to BIVI or Consultant immediately, before proceeding.

8) All corrective action taken must be approved by the Contractor and reviewed by the Owner or Consultant, and must be documented and forwarded to the Owner or Consultant.

9) All operating parameters are to be monitored and recorded at outlined intervals during periods of load testing.

10) Testing and qualification procedures are to be in compliance with engine company testing methods for commercial AC generator sets to accomplish tests specified herein as accepted by the Consultant/BIVI.

C. Test Ratings:

1) The generator set(s) shall be tested on restrictive load banks, at 0.8 power factor (PF), and at a minimum amperage determined as follows:

$$\text{AMPERES} = \frac{\text{KW} \times 1000}{\text{volts} \times 1.73 \times \text{PF}}$$

D. Each test log sheet shall include the following information from the generating system tested:

1) Engine-Generator Set Model Number

2) Diesel Engine Serial Number

3) Generator Model Number

4) Generator Serial Number

5) Generator Make or Manufacturer

6) Voltage Regulator Model Number

7) Voltage Regulator Serial Number

8) Voltage Regulator Make or Manufacturer

9) Control Panel Model Number

10) Control Panel Serial Number

11) Control Panel Make or Manufacturer

12) Governor Model Number

13) Governor Serial Number

14) Governor Make or Manufacturer

15) Customer Name and Job Identification

E. Automatic Start Cranking Test:

1) Interconnect control panel to engine per the appropriate wiring diagram.

a. Shutoff fuel supply

b. Turn selector switches to "RUN" position and initiate "Start"

c. Check "CRANK" time delay relay per specifications

d. Check "REST" time delay relay per specifications

e. Check "OVERALL CRANK" time delay relay per specifications

f. After time delay relays are checked, run complete crank cycle test

g. Verify that at the end of crank cycle test, overcrank failure occurs and that the overcrank light is energized and alarm sounds

h. Turn selector switch to "off" position - engine should stop

i. Turn on fuel valve supply and prime engine if required

j. Turn selector switch to "MANUAL" position. Engine should start and accelerate to rated speed

k. Turn selector switch to "OFF" position. Engine should stop

l. Turn selector switch to "MANUAL" position to restart engine

m. With engine running, follow procedure below to simulate an engine failure with each engine mounted (shutdown type) safety control

n. Overspeed switch (actual overspeed)

o. Water temperature switch (simulate condition) alarm and pre-alarm

p. Oil pressure switch (simulate condition) alarm and pre-alarm

q. Low water level (simulate) alarm and pre-alarm

r. Determine that auto-start cranking panel will shutdown engine, energize appropriate fault lamp and lock out panel against re-start until the selector switch has been manually rotated to the "STOP" position, and reset.

F. Safety Control Test:

1) Test and record the operation of all engine mounted safety devices.

2) Oil pressure switch: With engine running, close valve in line to oil pressure gauge/oil pressure switch. Place engine start switch in "OFF" position. After engine comes to rest, bleed pressure. As engine oil pressure decays, determine when the oil pressure switch contacts open/close. Record value of oil pressure at this point in psi. Open valve to full open after test.

3) High water temperature switch: With engine running, over-ride water temperature switch. Determine that engine shuts down.

4) Engine overspeed: Increase engine speed until overspeed contacts open and engine shuts down.

5) Low Water Temperature Switch (with engine stopped).

a. Verify that the appropriate control panel or annunciator panel indicating lamp or both are illuminated and the alarm horn is activated.

b. Verify that the silence switch(es) deactivates the alarm horn.

6) Low Water Level Switches: Operate contacts with external operation and verify shutdown and pre-alarms and verify coolant to determine pick-up of shutdown switch.

G. Load Bank Test:

1) Load bank test the engine-generator set at the ratings and time periods listed below. Record all operating parameters at indicated intervals.

2) Install a single pole switch across generator remote start contacts (transfer switch controls may be used).

3) Place generator panel controls in the Automatic Start position.

4) Close single pole switch in Item B, time and record the interval required for the engine to start, accelerate to speed and to apply resistive load bank load.

5) Apply 50% of load for first 30 minutes, 75% load for next 30 minutes. Apply 100% rated resistive load for 7 hours. Monitor and record all operating parameters at indicated intervals.

6) Remove all load and operate engine unloaded for 5 minutes or until pressures and temperatures stabilize.

7) Shut down engine

8) Single step load test and documentation

9) Safety Shut-down device testing

10) Rated and maximum power test

H. Building Load Test (If allowed by Owner, MOP required):

1) After generators have been load bank tested, the Contractor shall perform a complete emergency system load test with available building load. The generator(s) shall pick up and carry this load at rated operating voltage and frequency. This load test shall be performed on all generators provided. When the building is operational and each piece of electrical equipment requiring generator power is operation the Contractor shall perform 1 hour load test utilizing all building equipment for the load.

END OF SECTION

GENERATOR FULL LOAD TEST FORM

GENERATOR SET NO.: Serial NO.

Outside temperature: DATE:

Weather Conditions:

Outside Temperature (BEFORE TEST)

Data taken by:

		Room Temperature		Engine					Battery Charger		Load			
					Oil		Water							
	Time	Ambient	@ Rad.	Fuel PSI	°F	PSI	°F In	°F Out	Volts	Amp	Volts	Amp	KW	RPM/ Freq
Start														
+5 min														
+10 min														
+15 min														
+30 min														
+45 min														
+60 min														
+75 min														

+90 min														
+105 min														
+120 min														
+135 min														
+150 min														
+165 min														
+180 min														
+195 min														
+210 min														
+225 min														
+240 min														
+255 min														
+270 min														
+285 min														
+300 min														
+315 min														

+330 min													
+345 min													
+360 min													
+375 min													
+390 min													
+405 min													
+420 min													
+435 min													
+450 min													
+465 min													
+480 min													

Inside Temperature ater test:

GENERATOR FULL LOAD TEST FORM

(CONTINUED)

1. Prevent set from starting run complete Crank/Rest sequence by setting control switch to run.

Battery Voltage: Passed Failed

Battery Charge Rate: Volts: Amps:

2. Test Safeties: P = Passed F = Failed

	ALARMS	LOCAL	REMOTE
LOW JACKET WATER TEMP.			
HIGH WATER TEMP.			
LOW LUBE OIL PRESS			
HIGH DIESEL OIL LEVEL			
LOW DIESEL OIL LEVEL			
THREE HOUR MAIN FUEL SUPPLY			
BATTERY CHARGER FAILURE			
BATTERY			
OVERSPEED			
OVERCRANK			
LOW WATER LEVEL			
LOW WATER LEVEL PRE-ALARM			
HIGH WATER TEMP PRE-ALARM			
LOW OIL PRESSURE PRE-ALARM			
ENGINE RUNNING SENSOR			
OIL PRESSURE DROP-OUT			

2. Test “COLD” Start (Disconnect Power to Transfer Switch)

TIME FOR LOUVERS FULL OPEN. (8 SEC. MAX)	SEC.
TIME DELAY ON POWER FAILURE TO CRANK	SEC.
CRANKING TIME TO START	SEC.
TIME TO OPERATING SPEED (60 HZ)	SEC.
TIME TO TRANSFER ALL IMMEDIATE TRANSFER SWITCHES	SEC.

TIME DELAY TRANSFER SWITCHES TRANSFER AFTER TIME DELAY	YES	NO
VOLTAGE OVERSHOOT	YES	NO
FREQUENCY OVERSHOOT	YES	NO

OIL PRESSURE WATER TEMP

BATTERY CHARGE RATE: VOLTS AMPS

GENERATOR FULL LOAD TEST FORM

(CONTINUED)

ATTENDEES:

NAME	COMPANY	WITNESSED (SIGNATURE)

SECTION 263600 - AUTOMATIC TRANSFER SWITCH

PART 1 -GENERAL

description of work:

Automatic transfer switch(es)

Bypass Isolation Switch(es) and installation

STANDARDS

Transfer switches shall comply with latest edition of:

NFPA 110 Emergency and Standby Power System

NFPA 70 National Electrical Code

UL 1008 Automatic Transfer Switches

NEMA ICS10 AC Automatic Transfer Switches

SUBMITTALS

Submit complete shop drawings showing elevations, details, wiring diagrams, materials list, accessories, etc. for review before fabrication.

Shop drawings to include:

Scaled front, rear and end views of the transfer switch with material list and nameplate schedule.

Sectional view showing construction, size and location of bussing and cabling furnished. Include dimensioned plans showing minimum clearances, conductor entry provisions, and gutter space.

Schematic and Physical Wiring Diagrams for transfer switch controls, and accessories. Differentiate between manufacturer installed and field installed wiring.

Complete detailed instructions for operation and sequences.

Cut sheets.

SEISMIC REQUIREMENTS

This switchgear is located in a seismic zone 0. Switchgear shall be constructed with all necessary bracing required for installation in specified seismic zone.

related work

Section 16471 – Low Voltage Switchgear

Section 16621 - Engine Parallel System Functional Description with Automatic Transfer Switches

Section 16624 - Engine Starting Control Panel (for non parallel application)

PRODUCTS

AUTOMATIC TRANSFER SWITCH

The Transfer Switch shall be rated 600 volts, with a withstand current rating of 200 amperes at 480 volts, coordinated with current limiting fuses. The transfer switch shall be fixed mounted.

The Transfer Switch shall be mechanically held, electrically operated, rated for continuous loads.

All bussing in the transfer switch(es) shall be silver plated copper bus the size based on 65°C rise above 40°C ambient except minimum 1000 amperes/square inch, with fully overlapped joints.

Transfer Switch(es) shall be 4 - pole or overlapping neutral using silver alloy wiping copper contacts (use segmented contacts over 600 amperes) and separate arcing tips and/or contacts.

Transfer switches(es) shall be rated for all classes of load.

Transfer Switch Sensing and Controls may be microprocessor based and/or relay logic. Relays shall be continuous duty, industrial type with minimum contact rating of 10 amperes with LED pilot indicating operation with dust cover and retention clip. Controls shall be the latest standard product of the transfer switch manufacturer to provide functions listed below.

TRANSFER SWITCH CONTROL SYSTEM

The control module shall direct the operation of the transfer switch. The module's sensing and logic shall be a built-in microprocessor-based system for maximum reliability, minimum maintenance, and inherent digital communications capability. The control settings shall be stored in nonvolatile EEPROM or accepted equivalent. The module shall contain an integral programmable clock and calendar. The control module shall have a keyed disconnect plug to enable the control module to be disconnected from the transfer mechanism for routine maintenance.

The control module shall be mounted separately from the transfer mechanism unit for safety and ease of maintenance. Interfacing relays shall be industrial control grade plug-in type with dust cover as specified above.

The control module shall include programming keypad, alpha-numeric display for monitoring settings and diagnostic values, key-lockable program selector switch, light-emitting diode status indication, and user instructions. These features shall be user accessible when the enclosure door is closed.

The control module shall be capable of storing the following records in memory for access either locally (at the control module) or remotely (at a computer):

Number of hours transfer switch is in the emergency position (total and since record reset)

Number of hours the emergency is available (total and since record reset)

Total days that control has been energized (total and since record reset)

Total transfers in either direction (total and since record reset)

Date of record reset

Date of last exercise period

Date, time, and description of the last four source failures

Elapsed time during the most recent source outage

OPERATION

Source Voltages

The voltage of each phase of the normal source and a single phase of the emergency source shall be monitored with pickup adjustable from 75% to 100% and dropout adjustable from 70% to 95% of nominal.

An automatic minimum differential of 2% shall be maintained between pickup and dropout settings.

Repetitive accuracy of the setting shall be ± 2% or better over an operating temperature range of -20°F to 150°F (-29°C to 65.5°C).

The settings shall be fully field-adjustable by keypad or keyboard (local or remote) in increments of 1 Volt without opening the enclosure door and without the use of special tools or separate meters.

Factory settings shall be pickup at 95% and dropout at 85%.

A light-emitting diode shall indicate that normal and/or emergency voltage is within the set point parameter. The indication shall be viewable when the enclosure door is closed.

Time Delays

The control module shall include four time delays that are fully field-adjustable by keypad or keyboard in increments of 1 second over the entire range.

Adjustments and viewing of the time delay values shall be accessible when the enclosure door is closed.

Light emitting diodes shall indicate when the timing feature is running and when the time delay has ended.

Required Time Delays

Time delay for engine start to delay initiation of transfer for momentary source outages: Range 0-120 seconds. Factory set at 5 seconds.

Time delay for retransfer to commercial: Range 0-60 minutes. Factory set at 20 minutes.

Time delay for engine cooldown: Range 0-30 minutes. Factory set at 5 minutes.

Time delay for contactors both open - delayed transition time: Range 0-15 seconds. Factory set at 3 seconds. Provide separate adjustable delay for transition to normal and transition to emergency.

Time delay for transfer to emergency; Range 0-60 seconds to allow switches to transfer to generators in a sequence. Set as directed at start up.

Input values outside the allowable parameters shall cause a “range error” message to be displayed.

The user shall have the ability to manually program an engine start and run for a period of up to 72 hours in the loaded or unloaded mode of operation. The time delay transfer to emergency and/or normal may be bypassed during the run period. A numeric indication shall be displayed of the run time remaining in hours and minutes. The run period may be stopped at any time with a single key stroke. After the run period has stopped, the engine shall run unloaded for the cooldown time.

User terminals shall be available to connect a normally closed contact that, when opened, signals the control module to start and transfer load to the engine-generator. Closing these contacts shall initiate a retransfer and engine cooldown sequence. The load shall be transferred to an available utility source immediately if the generator source should fail.

The following features shall be built into the control module logic. These features shall be enabled at the factory or in the field by installing an insulated program jumper provided by the vendor as standard.

Extended Time Delay: Allows the time delay settings to be extended to 99 minutes.

Plant Exerciser: Programmable seven day, fourteen day or calendar exerciser; each exerciser mode shall be capable of performing up to two exercise runs in up to five exercise event periods. The exerciser period shall be programmed with the enclosure door closed. The exercise time may be reset at any time with a single key stroke. The engine shall be allowed to run when the exercise period is terminated.

All phases of normal and all or single phases of emergency shall be monitored for overvoltage and single phase of normal and emergency for over- and under-frequency. The values shall be programmed with the enclosure door closed.

Anti-single phasing protection shall detect regenerative voltage as a failed source condition.

Operation override shall function to bypass any manual switch accessories except "automatic-manual" switch, if the source to which the transfer switch is positioned fails and transfer the switch to the active source. This program jumper shall be factory installed.

Status Indicators shall consist of light-emitting diodes shall indicate the status of the following:

Contactor Position

System Status

Transfer Switch Position Sensing Fault

Transfer Switch Fail to Transfer

Internal Control Module Fault

Manual Transfer Operation

External Fault Condition (two inputs)

Not In Automatic

Programming Switch Not In Off

The system status messages shall also be shown on the alpha-numeric display.

A lamp test push button shall light all light-emitting diodes.

The control module shall have a three-position, key-operated, programming control switch. The key shall be removable in any position. The positions shall be:

Off-Allows all enabled accessories to be monitored only. Settings cannot be changed while in this position.

Local-Allows all enabled accessory settings to be changed by local keypad entry.

Remote-Allows all enabled accessories to be altered via the remote communications port.

Provide a two-position switch for "automatic-manual" modes. In automatic mode, all functions described herein shall be active. In the manual mode, the switch will ignore all commands to transfer automatically. Provide pushbuttons to transfer ATS between normal and emergency positions manually while operating in this mode.

A momentary-type test switch shall be provided to simulate a normal source failure and lock this mode until test is reset.

The transfer switch shall have load-shed and sequencing capability to allow up to nine selected loads to be disconnected prior to transfer in either direction. It shall be possible to vary the time sequence for reenergizing of the nine loads.

A set of gold-flashed contacts rated 10 amps, 28 VDC shall be provided for a low-voltage engine start signal when the normal source fails.

Furnish Two (2) extra auxiliary contacts closed on Normal contactor and two (2) auxiliary contacts closed on Emergency Contactor wired to terminal block for owners use.

COMMUNICATION CAPABILITIES

The transfer switch shall be capable of being connected in any of the following five network configurations. Interactive software developed for ATS applications shall be available. The software must monitor, allow alteration of values, and provide system diagnostics. All values and indications of the ATS keypad must be available through the networks.

Point-to-Point Connectivity

It shall be possible to connect the ATS directly to a personal computer in the following ways:

Local Connection-Maximum cable length 50 feet (15 meters) using RS232.

Local Connection-Maximum cable length 4000 feet (1219 meters) using RS422.

Remote Connection-Utilizing phone lines, modems, and RS232.

Multidrop Networks

Control modules shall be capable of being connected as a local area network using a shielded twisted pair. A single local area network shall be capable of addressing and interfacing with up to 128 control modules.

Local Connection-Total cable length of all drops (up to 128) is 4000 feet (1219) meters.

Remote Connection-Connect to a local network then utilize phone lines to monitor and control.

The minimum computer requirements for local or remote area networks are an IBM PC or true compatible with 512K RAM, disk drive, VGA or monochrome monitor, and MS-DOS 3.0 or higher.

It shall be possible to connect a printer to the computer for hard copy generation.

sequence of operation

Sequence of Automatic Transfer Operation:

When normal (commercial) service drops below the preset percent of rated voltage and remains for a specified time delay, contact closure in the transfer switch will signal the engine-generator to start. When generator output reaches proper voltage and frequency, the transfer switch will transfer load to the generator with a preset pause in the open position, set at 1 second.

When normal (commercial) source returns to preset percentage of rated voltage and after specified time delay, load retransfers to the normal source with a preset pause in the open position, set at 3 seconds.

Engine-generator start control shall remain closed to allow the engine-generator to run (unloaded) for preset time after retransfer before shutdown.

Control relays, etc., to reset instantaneously, ready for next automatic operation.

Sequence of Manual Operation:

Auto manual switch in "manual" position with amber LED lighted

No automatic start functions available

Requires manual start of engine generator(s)

Requires manual operation of pushbuttons to cause switch to transfer between sources, with preset pause in open position

Bypass Switch(es)

Provide load break Bypass-Isolation Switch for each automatic transfer switch where indicated on the drawings and specified herein. The switch shall allow bypass to both normal and emergency sources in a make-before-break operation to same source.

The switch shall provide a safe and convenient means for manually bypassing and isolating the automatic transfer switch (ATS) for maintenance or repair without interrupting load. Operation of the bypass-isolation switch shall be assured regardless of the position of the ATS. Indicating lights shall be provided to show the bypass-isolation switch in the bypass position, and in the fully isolated position. Positive sequencing of all contacts, with no possible intermediate position shall be accomplished through the manual operators from a dead front location. Testing during maintenance of the ATS for normal electrical operation shall be possible with the bypass switch in the bypass and isolated position. Inherent double throw (break-before-make) operation shall provide positive assurance against accidental short-circuiting of the normal and emergency power sources when ATS is in isolated position. The operating speed of the contacts shall be independent of the speed at which the handle is moved. The switch shall be fully manually operated and shall not be dependent upon electrical operators, relays, or interlocks for operation.

The main contacts and operating linkage shall be identical to the ATS except that the operation shall be manual. The switch shall have the same electrical ratings of ampacity, voltage, short circuit withstand, and temperature rise capability as the associated ATS, and shall be the load break type. The main contacts shall be mechanically locked in both the normal and bypass positions. Contacts shall be silver tungsten alloy protected by arcing contacts with magnetic blowouts on each pole. The switching mechanism shall provide "quick make" and "quick break" operation of the contacts.

If the ATS and bypass-isolation switch are mounted in a common enclosure, then each shall have a separate isolated compartment. The interconnections between the switches shall be provided by the manufacturer.

Necessary controls shall be provided to assure that the "engine run" circuit remains closed when the switch is in the bypass to emergency position, even though the associated transfer switch is in the "normal" position or completely removed from the enclosure.

The bypass-isolation switch shall be 3 pole configuration. A 4 pole switched neutral shall be provided if the ATS is designated as 4 pole with switched neutral for use with ground fault protection scheme. Overlapping neutral design is acceptable equivalent.

A solenoid interlock shall be provided to prevent the operator from switching the bypass-isolation switch to a dead source of power.

For proper system coordination, the bypass-isolation switch shall be listed by Underwriters' Laboratories Inc., under UL-1008 (accessory, transfer switch).

Enclosure

Furnish the transfer switch with NEMA 3R painted steel enclosure. Provide isolated [100%] Neutral bus and bonded 50% ground bus (1/4" x 3" minimum). Enclosure shall be mounted to concrete housekeeping pad per manufacturer's standard.

WIRING

Terminate all control circuits and wiring in the switchgear on 600 volt, barriered terminal blocks with permanent marking. Use insulated long barrel (dual crimp) locking fork, crimp on connectors equivalent to Thomas & Betts “Stakon”. All current transformer wiring shall terminate on shorting type terminal blocks. Identify control wiring with permanently marked PVC or vinyl wire markers on each wire with marking to correspond with terminal identification. Wire markers shall be equivalent to Thomas & Betts type WSL self laminating.

Lugs and cable connectors for power connections shall be solid copper barrel compression type, Burndy "Hydent" Thomas & Betts color keyed compression, Anderson VCL or approved equivalent. All lugs #1/0 and larger shall be equipped with two bolt tongues.

Where any wired ATS accessories and auxiliary contacts are provided and are wired out of plug-in/drawout ATS's, provide polarized nylon pluggable connector between ATS and terminal block to allow removal and reinstalling of ATS without disconnecting wires at ATS or terminal block. Connector shall be Amphenol or accepted equivalent.

Provide busway risers for all switches connected with busways. Bussing shall be the same as specified above.

Control fuses shall be plug-in, UL approved, indicating type, mounted on front panel of relay compartment and labeled, FIC Corp., or accepted equivalent by Bussman (HGC) with CLF fuses or accepted equivalent.

Acceptable TRANSFER SWITCH Manufacturers:

ASCO

Russelectric

Cummins

Zenith

Kohler

Generac

EXECUTION

FACTORY TESTING

Perform complete operational tests of the automatic transfer switch, as follows:

Demonstrate complete transition operation between sources.

Simulate all control and relay functions.

Simulate all communication functions.

Engineer's representative and the Owner's representative may witness factory tests, and review transfer switch operation.

Inform Engineer two weeks prior to tests, and arrange for representatives to be present at the time of tests.

Cost of Engineer's and Owner's factory visit(s) will not be part of contract.

FIELD TESTING

After installation of transfer switch(es), test as follows:

Demonstrate all functions and communications tests by emulating a power loss and transfer under normal operating conditions.

Verify all functions of the transfer switch are operable after installation.

Provide engineer and owner with documentation indicating each item tested, the test performed, and the performance of equipment as "operational". Include any failures, repairs, etc.

The Testing Contractor shall meet OSHA criteria for accreditation of Testing Laboratories, Title 29, Part 1907.

Transfer Switch manufacturer to furnish Owner's personnel operating and maintenance training at the owners building for one (1) day at completion of construction. Time and date selected by Owner.

GUARANTEE:

Furnish Owner/Engineer with written guarantee, stating that if workmanship and/or materials executed under this division is proven defective within one (1) year from date of Owner acceptance, such defects and other work damaged will be repaired and/or replaced with parts and labor installed at the site of the work.

Provide certificate signed by the manufacturer certifying that the product furnished complies with requirements and that the switches have been tested for the short-circuit closing and withstand rating applicable to the units for this project.

CABLE FEEDERS

Cable feeders shall be neatly formed and bounded. Identify cable feeders in transfer switch with laminated nameplates fastened to cable circuits with Thomas & Betts "Tyraps".

INSTALLATION

Secure transfer switch to concrete housekeeping pad as recommended by manufacturer.

Provide all necessary bracing and additional anchors required to secure transfer switch(es) for seismic zone specified above.

END OF SECTION

SECTION 26 41 13 - LIGHTNING PROTECTION SYSTEM

GENERAL

SCOPE

Furnish and install all materials and labor required to provide a complete functional lightning protection and common ground system for the building as shown and detailed on the plans, in strict accordance with this section of the specifications and the applicable contract drawings.

STANDARDS AND QUALITY ASSURANCE

The following specifications and standards of the latest current issue form a part of this specification.

N.F.P.A. - Code No. 780
LPI Installation Standard 175
UL Standard 96A

All materials for this system shall be new and the standard product of a manufacturer regularly engaged in the production of lightning protection systems and shall be of the latest approved designs. Equipment shall be approved for UL listing.

The system shall be installed under the direct job site supervision of Certified Master Installer.

SHOP DRAWINGS

Product data on conductors, connections, points, adhesives when used, etc.

Complete scaled shop drawings of the entire lightning protection system showing the type, size, mounting details, and location of all equipment, grounds and cable routings, etc., shall be submitted to the Consultant for approval prior to start of work. If any departures of consequence from the Approved Shop Drawings are deemed necessary by the Contractor, details thereof shall be submitted and approval obtained, before work is resumed and completed.

Shop drawing, and maintenance data submittals shall be in accordance with requirements Division 1, Section 01300.

SYSTEM DESCRIPTION

System materials in general shall be copper and high copper-content bronze castings, and shall comply in weight, size, and composition for the class of structure to be protected, as specified in above mentioned Codes. The system shall consist of all necessary cables, air terminals, mounting bases, fittings, couplings, connectors, fasteners, etc., as required to give a complete and coordinated system. All cable and all air terminals shall bear proper UL labels.

System conductors shall be concealed wherever practical. All main downleads and roof risers shall be run down exterior of building and hidden as much as possible in the building crevices. Exact routing of downleads shall be approved by Consultant/Owner. Paint downleads to match building color; where shown, run leads concealed in conduit.

All system fittings except cable holders, regardless of Structure classification shall be heavy-duty type made from bronze castings and secured with bolted-pressure clamps. Pressure plates made from stamped or pressed metal parts, or fittings utilizing crimp-type pressure devices will not be allowed. All bolts, screws and related type hardware shall be 300 series stainless steel.

All cable to cable, cable to lug, cable to ground rod, and cable to structural steel connections shall be made with Exothermic welded or accepted equivalent. Contractor shall notify Engineer where connections cannot be used.

PRODUCTS

MATERIALS AND EQUIPMENT

All materials shall be copper, or copper alloys as described above, UL approved and labeled as required, and of the size, weight, and construction to suit the application where used in accordance with Code requirements for the Class of structure involved, and as per manufacturer recommendations.

Air terminals shall be solid, ½" diameter round copper bar, full nickel plated, and of sufficient length to project 10" minimum above the object to be protected, and UL labeled. Locate and space points in accordance with L.P.I. requirements.

Point bases shall be cast bronze with bolt-pressure cable connector plates. Parapet type units shall provide for 1½" coping overhand. Adhesive type bases for flat roofs shall have a minimum surface contact area of 18.5 square inches and be secure with a proper adhesive.

Primary conductors shall be UL labeled, Class II, braided smooth twist or rope-lay stranded commercially pure tinned copper cable (minimum 375 pounds per 1000 feet).

Secondary conductors shall be UL labeled, Class II, braided smooth or rope-lay stranded commercially pure tinned copper cable. Minimum 130 pounds per 1000 feet

Ground rods shall be 5/8" diameter copper clad steel by 8'-0" long connected to exterior ring ground cable or downlead cable when no ring is present with cadweld or accepted equivalent connection. Top driven minimum of 2'-6" feet below grade to the level of the ground ring conductor.

Cable fasteners shall be substantial in construction, made of copper or bronze and compatible with the conductor and mounting surfaces, and spaced according to Code requirements and good installation practices.

Bonding devices, cable splices, and miscellaneous connectors shall be Exothermic welded as manufactured by Cadweld or accepted equivalent, unless substrate is unacceptable for welding. When mechanical connections must be used, use cast bronze with bolt pressure cable connections with stainless steel hardware. Any connections between dissimilar metals shall be made with approved bi-metallic connectors or spacers.

Bonds to galvanized steel shall be with aluminum connectors and tied to the copper system with a bi-metal connector.

Use Cadweld lugs where possible for bolted connections. All cable connections and connections to equipment, structural frames, etc., shall be made with "Cadweld" or approved equivalent.

All adhesives used to attach materials to roof or other substrate shall be approved by the roofer/substrate manufacturer for the intended purpose and shall not cause any damage to the roof/substrate.

Acceptable lightning protection system Manufacturers:

AC Lightning Protection
Thompson Lightning Protection
Robbins Lightning Protection

EXECUTION

INSTALLATION

All equipment and materials shall be installed in a neat workmanlike manner by skilled installers, under the direct field supervision of a Certified Master Installer who has qualified under the LPI's Certification Program.

System installation shall be complete; including necessary cable networks on the roof for air terminals and devices, bonding networks and taps for grounding equipment and roof metals, and downlead conductors. Where downleads and risers penetrate roofs and walls, suitable 1/2" copper rod type thru-roof connectors shall be used, equipped with necessary lead or neoprene washers and nuts for watertight seal. Adhesive-type point bases and cable holders shall be installed on build-up roof areas before application of roof gravels.

Provide copper pitch pockets for penetrations of built up roof. Provide other types of roof penetrations compatible with type roof installed. System Installers shall carefully coordinate all Lightning Protection work with the roofing contractor to prevent an potential for damage to roof, parapets, flashings, etc. System installers shall carefully coordinate their work with all other trades to insure a complete, correct, neat, and unobtrusive installation.

BONDING AND SYSTEM GROUNDS

A common ground shall be provided between the lightning protection system and the building electric and telephone service grounds. In addition, all underground metallic piping systems shall be bonded with full size conductor; including water, gas, sewer, fuel oil, and any other piping system, at points where these pipings enter the building. Bonding of utility piping systems is subject to their cooperation and approval.

Bonding of all metallic objects and systems at roof levels and elsewhere on the structure shall be complete. Primary bonds for metal bodies of conductance shall be bonded with appropriate fittings and full-size conductor; and shall consist of but not limited to the following: Roof exhaust fans, HVAC units with related piping and ductwork, exhaust vents and any other roof piping systems, cooling towers, elevator hoist machinery supports and rails systems, window washing tracks, antenna mast for TV, radio or microwave antennas, flag poles, roof handrails and/or decorative screens, roof ladders, skylights, metal stacks, etc. Exterior architectural metal fascia and/or curtain walls or mullions which extend the full height of the structure shall also be bonded, if not inherently bonded thru the building frame.

Metal bodies of inductance located within six feet of a primary conductor or object with primary bonds, shall be bonded with secondary cable and fittings. Typical of these are: plumbing vent stacks, roof flashings, parapet coping caps, gravel guards, isolated metal building panels or siding, roof drains, down spouts, roof ventilators, exterior balcony handrails, any other sizeable miscellaneous metal masses, etc.

SUPERVISION AND CERTIFICATION

Contractor shall have a locator survey done to identify all utility piping, ducts, all underground obstructions, piping from building, etc., prior to driving new ground rods. Ground rod location shall be adjusted to avoid all obstructions. Obtain all permits and right of way from authorities having jurisdiction as required to install new ground rods outside property line.

The manufacturer's local representative shall be a Certified Master Installer and shall provide direct jobsite technical supervision to Contractor's personnel during installation to insure compliance with all Code requirements.

Upon job completion, Contractors shall furnish Owners with written certification that system is installed in full compliance with above Codes, and UL Master "C" Label, with the exception of Exothermic welded or accepted equivalent connections.

END OF SECTION 264113

SECTION 26 43 13 - TRANSIENT VOLTAGE SURGE PROTECTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes TVSSs for low-voltage power, control, and communication equipment.

B. Related Sections include the following:

1. Division 26 Section "Wiring Devices"
2. Division 26 Section "Distribution Panelboards"
3. Division 26 Section "Panelboards" and “Integrated Panel Centers” for factory-installed TVSSs.

1.3 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. VPR: Voltage protection rating.

C. TVSS: Transient voltage surge suppressor.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating weights, operating characteristics, furnished specialties, and accessories.

B. Product Certificates: For transient voltage suppression devices, signed by product manufacturer certifying compliance with the following standards:

1. UL 1283.
2. UL 1449.

C. Qualification Data: For testing agency.

D. Field quality-control test reports, including the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Failed test results and corrective action taken to achieve requirements.

E. Operation and Maintenance Data: For transient voltage suppression devices to include in emergency, operation, and maintenance manuals.

F. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer.

C. Product Options: Drawings indicate size, dimensional requirements, and electrical performance of suppressors and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits."

F. Comply with NEMA LS 1, "Low Voltage Surge Protection Devices."

G. Comply with UL 1283, "Electromagnetic Interference Filters," and UL 1449, "Transient Voltage Surge Suppressors."

1.6 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

B. Service Conditions: Rate surge protection devices for continuous operation under the following conditions, unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
2. Operating Temperature: 30° to 120° F.
3. Humidity: 0 to 85 percent, noncondensing.
4. Altitude: Less than 20,000 feet above sea level.

1.7 COORDINATION

A. Coordinate location of field-mounted surge suppressors to allow adequate clearances for maintenance.

B. Coordinate surge protection devices with Division 16 Section "Electrical Power Monitoring and Control."

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within five years from date of Substantial Completion.

B. Special Warranty for Cord-Connected, Plug-in Surge Suppressors: Manufacturer's standard form in which manufacturer agrees to repair or replace electronic equipment connected to circuits protected by surge suppressors.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Replaceable Protection Modules: One of each size and type installed.

PART 2 - PRODUCTS

2.1 GENERAL

A. TVSS shall meet all the requirements and test procedures as outlined in NEMA LS-1 Standards “LOW VOLTAGE SURGE PROTECTIVE DEVICES”. The unit shall be tested as a complete unit, with all fuses in place. A unit tested without fuses shall be considered as not compliant to NEMA LS-1

1. Nominal voltage rating 277/480, 3 phase, 4 wire
2. Maximum Continuous Operating Voltage Rating: Shall not be less than 125% of the nominal voltage rating.
3. The suppression system shall incorporate thermally protected metal oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cell, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.
4. Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum surge current capacity based on ANSI / IEEE C62.41			
Categor	Application	Per Phase	Per Mode
C	Service Entrance Locations (Switchboards	300 kA	150 kA
B	High Exposure Roof Top Locations (Distribution Panelboards)	160 kA	80 kA

A	Branch Locations (Panelboards, MCCs, Busway)	80 kA	40 kA

5. Repetitive Surge Current Capability: > 5,500 tested impulses per mode at IEEE Category C3 [20KV, 10KA] with less than 10% deviation from start to finish at 5,500 impulses.

6. UL 1449 Third Edition Listed, UL 1283 Listed Clamp Voltage ratings:

   L-N 120/208 600 VOLTS, 277/480 1000 VOLTS

7. EMI/RFI High Frequency Noise Filter Ratings: 100 KHZ – 80dB,

   1MHZ=65dB, 10 MHZ – 65 dB, 100 MHZ – 80Db

8. The manufacturer shall provide a full twenty (20) year warranty against any SPD part failure when installed in compliance with manufacturer's written instructions and any applicable national or local code.
9. Optional-The unit shall have NEMA certified safety interlocked integral disconnect switch located within the unit. The manual operator for the disconnect switch shall be externally located and rated for 200,000 AIC.

2.2 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Current Technology, Inc.
2. Cutler-Hammer, Inc.; Eaton Corporation.
3. General Electric Company.
4. Innovative Technology, Inc.
5. Intermatic, Inc.
6. Leviton Mfg. Company Inc.
7. Liebert Corporation; a division of Emerson.
8. Siemens Energy & Automation, Inc.
9. Square D; Schneider Electric.

2.3 SERVICE ENTRANCE SUPPRESSORS

A. Surge Protection Device Description: Non-modular, sine-wave-tracking type with the following features and accessories:

1. LED indicator lights for power and protection status.
2. Audible alarm, with silencing switch, to indicate when protection has failed.
3. One set of dry contacts rated at 1A minimum and 250-V ac, for remote monitoring of protection status.

B. Surge Protection Device Description: Modular design with field-replaceable modules, sine-wave-tracking type with the following features and accessories:

1. Fuses, rated at 200-kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring.
3. Integral disconnect switch.
4. Redundant suppression circuits.
5. Redundant replaceable modules.
6. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
7. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
8. LED indicator lights for power and protection status.
9. Audible alarm, with silencing switch, to indicate when protection has failed.
10. One set of dry contacts rated at 1A minimum and 250-V ac, for remote monitoring of protection status. Coordinate with building power monitoring and control system.
11. Surge-event operations counter.

C. Peak Single-Impulse Surge Current Rating: 160 kA per phase.

D. Connection Means: Permanently wired.

E. Protection modes and UL 1449 VPR for grounded wye circuits with voltages of 480Y/277, 208/120, 3-phase, 4-wire circuits shall be as follows:

1. Line to Neutral: 1200 V for 480Y/277; 800 V for 208Y/120.
2. Line to Ground: 1200 V for 480Y/277; 800 V for 208Y/120.
3. Neutral to Ground: 1200 V for 480Y/277; 800 V for 208Y/120.

2.4 PANELBOARD SUPPRESSORS

A. Surge Protection Device Description: Non-modular, sine-wave-tracking type with the following features and accessories:

1. LED indicator lights for power and protection status.
2. Audible alarm, with silencing switch, to indicate when protection has failed.
3. One set of dry contacts rated at 1A minimum and 250-V ac, for remote monitoring of protection status.

B. Surge Protection Device Description: Modular design with field-replaceable modules, sign-wave-tracking type with the following features and accessories:

1. Fuses, rated at 200-kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring.
3. Integral disconnect switch.
4. Redundant suppression circuits.
5. Redundant replaceable modules.
6. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
7. LED indicator lights for power and protection status.
8. Audible alarm, with silencing switch, to indicate when protection has failed.
9. One set of dry contacts rated at 5 A and 250-V, ac, for remote monitoring of protection status. Coordinate with building power monitoring and control system.
10. Surge-event operations counter.

C. Peak Single-Impulse Surge Current Rating: 80 kA per phase.

D. Protection modes and UL 1449 VPR for grounded wye circuits with voltages of 480Y/277; 208Y/120, 3-phase, 4-wire circuits shall be as follows:

1. Line to Neutral: 1200 V for 480Y/277, 800 V for 208Y/120.
2. Line to Ground: 1200 V for 480Y/277, 800 V for 208Y/120
3. Neutral to Ground: 1200 V for 480Y/277, 800 V for 208Y/120.

2.5 ENCLOSURES

A. NEMA 250, with type matching the enclosure of panel or device being protected.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTION DEVICES

A. Install devices at service entrance on load side, with ground lead bonded to service entrance ground.

B. Install devices for panelboard and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

1. Provide multipole, 30A circuit breaker as a dedicated disconnect for suppressor, unless otherwise indicated.

3.2 PLACING SYSTEM INTO SERVICE

A. Do not energize or connect service entrance equipment or panelboards to their sources until surge protection devices are installed and connected.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust equipment installation, including connections, and to assist in field testing. Report results in writing.

1. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. Testing: Engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports:

C. Testing: Perform the following field tests and inspections and prepare test reports:

1. After installing surge protection devices, but before electrical circuitry has been energized, test for compliance with requirements.
2. Complete startup checks according to manufacturer's written instructions.
3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.

D. Remove and replace malfunctioning units and retest as specified above.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transient voltage suppression devices. Refer to Division 01 Section "Demonstration and Training."

3.5 COMMISSIONING

A. The unit shall be installed as recommended by the unit manufacturer in the electric room as shown on the drawings.

B. Local Factory representative shall perform start up testing. Factory trained representative shall test the installed units with a portable surge generator to verify that the unit is suppressing voltage within factory guidelines – in all modes. Also, the testing will verify the integrity of the neutral to ground bond [XO]. Additionally, testing shall be done with a factory meter to verify 100% suppression capability in all modes of the MOV’s and filters. The test report shall be sent to the specifying engineer for the project records to verify performance.

END OF SECTION 264313

SECTION 26 51 19 – LED INTERIOR LIGHTING

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Interior lighting fixtures, lamps, and ballasts.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.

B. See Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.02 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes.

B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.

C. Field quality-control test reports.

1.03 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of interior lighting fixtures of sizes, types and ratings required, whose products have been in satisfactory use in similar service for not less than five (5) years.

B. Installer's Qualifications: Firms with at least three (3) years of successful installation experience on projects with interior lighting fixture work similar to that required for this project.

C. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and NEC Articles 220, 410, and 510 as applicable to installation, and construction of interior building lighting fixtures.

D. NEMA Compliance: Comply with applicable requirements of NEMA Stds Pub/No.'s LE 1 and LE 2 pertaining to lighting equipment.

E. UL Compliance: Comply with UL standards, including UL 486A and B, pertaining to interior lighting fixtures. Provide interior lighting fixtures and components which are UL-listed and labeled.

F. Work in this division shall include all lighting fixtures as specified and as called for in the Electrical Scope of Work and shall also include lamps as required installed in fixtures.

Lighting fixtures shall be complete including hickeys, suspension nipples, connectors and all other material and equipment as required for re-hanging fixtures in accordance with the National Electrical Code. Fixtures and lamps shall be wiped clean before and after installation.

G. LED fixtures shall comply with UL 1598 and UL 8750.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Basis-of-Design Product: The design for each lighting fixture is based on the product named in the schedule. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified in the schedule.

2.02 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Metal Parts: Free of burrs and sharp corners and edges.

C. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

E. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.
4. Laminated Silver Metallized Film: 90 percent.

F. Plastic Diffusers, Covers, and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
   b. UV stabilized.
2. Glass: Annealed crystal glass, unless otherwise indicated.

G. Any flat acrylic lens specified in fluorescent fixtures shall be a minimum of .125" thick, KSH type K12, or approved equal, unless otherwise shown in schedule on fixtures.

H. Fixtures shall be wired with color coded fixture wire approved for temperature involved. Circuitry wiring run in fluorescent fixture channels shall be 'THHN" or "XHHW" and not less than #12 AWG.

2.03 EXIT LIGHTS

A. Illumination source shall be Light EMITTING Diodes (LED's). Provide automatic transfer circuit to transfer to battery source on loss of AC source.

B. Exit lights furnished with 6" high stencil letters. Use letter coloring as defined in light fixture schedule.

2.04 DRIVERS

A. LED Drivers shall be electronic type, labeled as compliant with radio frequency interference (RFI) requirements of FCC Title 47 Part 15, and comply with NEMA SSL 1 “Electronic Drivers for LED Devices, Arrays, or Systems”. LED drivers shall have a sound rating of “A”, have a minimum efficiency of 85%, and be rated for a THD of less than 20 percent at all input voltages.

B. Ballasts and drivers shall be rated for the ambient temperatures in which they are located.

C. All drivers shall be for operating at 120 or 277 volts as required. Contractor shall verify voltage prior to submission of shop drawings.

2.05 EMERGENCY LIGHTING UNITS

A. Description: Self-contained units complying with UL 924.

1. Battery: Sealed, maintenance-free, lead-acid type rated for automatic 90-minute operation minimum.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when power supply circuit voltage fails. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Battery-backed LED emergency lighting fixtures shall consist of a normal LED fixture with some or all of the LEDs connected to a battery or charger. The battery shall be nickel cadmium and sized for a minimum of 90 minutes of fixture operation. The charger shall be solid-state and provide overload, short circuit, brownout and low battery voltage protection. The battery and charger shall include self-diagnostic and self-exercising circuitry to exercise and test itself for 5 minutes every month and for 30 minutes every 6 months. The fixture shall include a test/monitor module with LED status indicating lights mounted to be visible to the public. The fixture shall not contain an audible alarm.

B. Acceptable Battery Manufacturers
   1. Bodine
   2. IOTA
   3. As specified in light fixture schedule

2.06 LAMPS

A. LM80 rated fixtures only. LED diodes shall have a CRI minimum of 82 and CCT (correlated color temperature) of 4000K unless indicated differently on light fixture schedule. Rated LED lamp life shall be 50,000 hours minimum. Driver shall be internal to LED fixtures and have a nominal operating voltage of 120Vac to 277Vac.

2.07 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 0.5-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two (2), 0.5-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gauge.

E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gauge.

F. Rod Hangers: 0.1875-inch minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture. Contractor shall coordinate fixture mounting with architectural ceiling type to verify compatibility.

B. Comply with NFPA 70 and NEC section 410 for minimum fixture supports.

C. Suspended Lighting Fixture Support:
   1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
   2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
   3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

D. Adjust aimable lighting fixtures to provide required light intensities.

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

F. Hand indirect light fixture by use of aircraft cable unless otherwise indicated.

3.02 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 265100

SECTION 26 53 00 - EMERGENCY LIGHTING FIXTURES

General

INCLUDES

This Section includes emergency light sets, exit fixtures with integral emergency battery backup, and emergency fluorescent fixture power supplies with integral battery backup.

Related Sections: The following Section contain requirements that relate to this Section:

1. *Division 26 Section 265100, "Interior Lighting" for regular fixtures that may be connected to emergency circuits to provide emergency lighting.*

SUBMITTALS

General:

1. *Submittals shall be made on all items in this section and shall be in accordance with the General Conditions.*

Product Data: Submit manufacturer's technical product data, independent testing lab photometric data, including fixture specifications and installation instructions, for each type of emergency unit required. Include data substantiating that materials comply with requirements.

Maintenance Data: Submit maintenance data and parts lists for each type of emergency unit installed, including furnished specialties and accessories. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of the General Conditions of this Specification.

Samples of specific individual products for approval where indicated.

PREREQUISITE CONDITIONS

The General Conditions, Supplemental General Conditions and Special Conditions are part of this contract and requirements set forth in those sections apply to all work in this division of the specifications.

Products

EMERGENCY LIGHTING FIXTURES

Quality Assurance

Manufacturer's Qualifications: Firms regularly engaged in manufacture of interior lighting fixtures of sizes, types and ratings required, whose products have been in satisfactory use in similar service for not less than five (5) years. All units specified in this section of the specifications hereinafter shall be furnished with not less than a five (5) year prorated warranty and not less than one year full replacement.

Installer's Qualifications: Firms with at least three (3) years of successful installation experience on projects with interior lighting fixture work similar to that required for this project.

Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

UL Compliance: Emergency lighting fixtures shall be UL listed and labeled.

NFPA Compliance: Comply with applicable requirements of NFPA 101, "Life Safety Code."

Local Code Compliance: Comply with applicable local codes and regulations for emergency lighting and exit signage including, but not limited to, colors and letter heights for exit signs.

Deliver products in factory containers; store in clean, dry space in original container. Protect products from fumes and construction traffic.

Furnish stock of replacement lamps amounting to 15 percent (but not less than one lamp in each case) of each type and size lamp used in each type unit.

The following features apply to designer series type emergency light sets:

Self-contained emergency lighting units with style, shape, and trim as indicated.

Battery: Sealed, maintenance-free, lead-acid type with 10 year nominal life.

Charger: Minimum two-rate, fully automatic, solid-state type, with sealed transfer relay.

Operation: Relay turns lamp on automatically when supply circuit voltage drops to 80 percent of nominal or below. Lamp operates for duration of outage, up to 1.5 hours. Lamp automatically disconnected from battery of voltage approaches deep-discharge level. When normal voltage is restored, battery is automatically recharged within 16 hours and then floated on trickle charge.

Control panel contains low-voltage disconnect switch, LED indicator light, voltmeter, test switch, and concealed terminals for remote lamp head connection.

Cylinder Style: Lamp, battery, charger, and relay mounted in cylindrical housing. Unit shall have the following features:

Cylinder shall be mounted on metal base with locking swivel joint providing 180 deg, 2-way lamp aiming.

Shallow profile base shall mount on wall or ceiling.

Finish: Matte white for exposed parts, or as selected by the Architect.

Recessed or Semi-recessed Type with Lens: Wall or ceiling mounted with the following features:

Lamps and reflectors as indicated.

Finish: Matte white for exposed parts, or as selected by the Architect.
Trim at wall or ceiling conceals fixture opening.
Lens: 0.125-inch thick prismatic acrylic.

Surface-Mounted Type with Lens: Wall or ceiling-mounted unit with the following features:

Lamps and reflectors as indicated.
Finish: Matte white for exposed parts or as selected by the Architect.
Lens: 0.125-inch thick prismatic acrylic.

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include but are not limited to the following:

Chloride Systems
Sure-Lites
Infinity
Dual-lite
Highlites Inc.
Hubbell, Inc.
Lithonia Lighting
Thomas Industries, Inc
Yorklite Div. Widelite Inc.

The following features apply to Die Cast Self-contained, a.c. battery-illuminated exit sign unit, universal mounting with downlight.

Lamps: Manufacturer's standard, furnished with unit.

Style, shape, trim, material, finish, and arrangement of housing as indicated.

Faceplate: Aluminum stencil face with red high-impact, UL 94 V-O rated, plastic letters and snap out arrows.

Mounting provisions shall suit individual installation conditions.

Battery: Sealed, maintenance-free, lead-acid type, with 10-year nominal life.

Charger: Minimum 2-rate, fully automatic, solid-state type, with sealed transfer relay.

Finish: Matte white for exposed parts, or as selected by the Architect.

Operation: Sign is illuminated by a.c. powered lamps under normal conditions. Relay turns emergency lamps on automatically when supply circuit voltage drops to 80 percent of nominal or below. Lamps operate for duration of outage, up to 1.5 hours. Lamps automatically disconnect from battery when voltage approaches deep-discharge value. When normal voltage is restored, a.c. powered lamps are relighted and d.c. lamps are switched off. Battery is automatically recharged within 16 hours and maintained on trickle charge.

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include but are not limited to the following:

Devine Design, Inc.
Halo Lighting
Highlites Inc.
Hubbell, Inc.
Lithonia Lighting
Thomas Industries, Inc.

The following features apply to internal type inverter units for designated fluorescent fixtures, provided under Division 26 Section "Interior Lighting" provide internal self-contained, modular, battery-inverter unit, factory mounted within the fixture body.

Arrange unit with test switch and LED indicator light, visible and accessible without opening fixture or entering ceiling space.

Battery: Sealed, maintenance-free, nickel-cadmium type, with normal 10-year life, minimum.

Charger: Fully automatic, solid-state, constant-current type.

Operation: Relay turns two lamps on automatically when supply circuit voltage drops to 80 percent of nominal or below. Lamps operate for duration of outage, up to 1.5 hours. When normal voltage is restored, battery is automatically recharged within 12 hours. Lamp lumen shall not be less than 900 lumens throughout specified operation period.

External Type: For designated fluorescent fixtures, provided under Division 26 Section "Interior Lighting" provide external self-contained, modular, battery-inverter unit.

Arrange unit with test switch and LED indicator light, visible and accessible without entering ceiling space.

Battery: Sealed, maintenance-free, nickel-cadmium type, with normal 10-year life, minimum.

Charger: Fully automatic, solid-state, constant-current type.

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include but are not limited to the following:

Manufacturers: Subject to compliance with requirements, provide products by the following:

Bodine Inc.
Chloride Systems
Dual-Lite, Inc.
Highlites Inc.
Hubbell, Inc.
Siltron Illumination, Inc.

INSTALLATION

Setting and Securing: Set units plumb, square, and level with ceiling and walls and secure in accordance with manufacturer's written instructions and approved shop drawings. Conform to the requirements of NFPA 70.

Mounting heights specified or indicated are to bottom of fixture for suspended or ceiling-mounted fixtures and to center of fixture for wall-mounted fixtures.

Recessed and semi-recessed fixtures may be supported from suspended ceiling support system if the ceiling system support rods or wires are installed at a minimum of four rods or wires per fixture and located not more than 6 inches from fixture corners. For fixtures smaller than the ceiling grid, install a minimum of four rods or wires per fixture and locate at corner of the ceiling grid in which the fixture is located. Do not support fixtures by ceiling acoustical panels. Where fixtures smaller than the ceiling grid are indicated to be centered in the acoustical panel, support fixtures independently with at least two 3/4-inch metal channels spanning and secured to the ceiling tees. Rods or wires for lighting fixture supports shall conform to the requirements of Section "Acoustical Treatment." Install support clips for recessed fixtures, securely fastened to ceiling grid members, at or near each fixture corner.

Lamping and Connection: Lamp units in accordance with manufacturer's instructions. Make external wiring connections required for proper functioning.

Coordinate with other electrical installations as appropriate for proper installation of emergency lighting fixtures.

Clean emergency units light set upon completion of installation.

Adjust aimable fixtures to provide light intensities in egress paths.

Ground non-current-carrying parts of equipment; where the copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.

Tighten grounding connections to comply with tightening torques specified in UL Standard 486A.

execution

FIELD QUALITY CONTROL

Tests: After emergency lighting units have been installed and building circuits have been energized with normal power source, apply and interrupt electrical energy to demonstrate proper operation. Remove and replace malfunctioning units with new units and proceed with retesting. Give the Architect advance notice of dates and times for all field tests. Provide instruments as required to make positive observation of test results. Include the following in tests:

Duration of supply

Low battery voltage shutdown

Normal transfer to battery source and re-transfer to normal

Low supply voltage transfer

Insulation Resistance Test: Perform as specified in Division 26 Section "Low Voltage Electrical Power Conductors and Cables" both before and after connection of fixtures and equipment.

Electrical Continuity Tests: Perform as specified in Division 26 Section "Low Voltage Electrical Power Conductors and Cables".

Lamp Replacement: Prior to tests, install new lamps in emergency lighting units. After testing, place malfunctioning lamps.

END OF SECTION 265300

SECTION 27 05 00 - COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SLEEVES FOR PATHWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized-steel sheet.

D. Sleeve Seals: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Stainless steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.2 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 GENERAL COMMUNICATION EQUIPMENT INSTALLATION REQUIREMENTS

A. Install communication equipment to allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.

B. Install communication equipment to provide for ease of disconnecting the equipment with minimum interference to other installations.

C. Install communication equipment to allow right of way for piping and conduit installed at required slope.

D. Install communication equipment to ensure that connecting pathways and cables are clear of obstructions and of the working and access space of other equipment.

E. Install required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

F. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Comply with requirements in Division 08 Section "Access Doors and Frames."

G. Install sleeve and sleeve seals of type and number required for sealing communication service penetrations of exterior walls.

3.2 SLEEVE AND SLEEVE-SEALS INSTALLATION

A. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

B. Cut sleeves to length for mounting flush with both wall surfaces.

C. Extend sleeves installed in floors 2 inches above finished floor level.

D. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and cable unless sleeve seal is to be installed.

E. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

F. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 07 Section "Joint Sealants."

G. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.

H. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

I. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between cable and sleeve for installing mechanical sleeve seals.

3.3 FIRESTOPPING

A. Apply firestopping to communications penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Comply with requirements in Division 07 Section "Penetration Firestopping."

END OF SECTION 270500

SECTION 27 05 26 - GROUNDING AND BONDING FOR COMMUNICATIONS

General

INCLUDES

The extent of electrical grounding and bonding work is indicated by drawings and schedules and as specified herein. Grounding and bonding work is defined to encompass systems, circuits, and equipment.

The type of electrical grounding and bonding work specified in this section includes the following:

Solidly grounded systems

Application of electrical grounding and bonding work in this section includes the following:

Exposed metal piping
Electrical power systems
Grounding electrodes
Raceways
Enclosures
Equipment

SUBMITTALS

General:

Submittals shall be made on all items in this section and shall be in accordance with the General Conditions.

Product Data: Submit manufacturer's technical product data, including specifications and installation instructions, for each type of grounding system required. Include data substantiating that materials comply with requirements.

Submit wiring diagrams for electrical grounding and bonding work which indicates layout of ground rings, location of system grounding electrode connections, routing of grounding electrode conductors, also include diagrams for circuits and equipment grounding connections.

Submit maintenance data and parts lists for each type of grounding system installed, including furnished specialties and accessories. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of the General Conditions of this Specification.

Submit product data for the following:

TMGB busbar

TGB busbar
Equipment rack busbars
Two hole and one hole lugs
No. 3/0 AWG and No. 6 AWG conductors

REFERENCES

ANSI/TIA/EIA-607 - Commercial Building Grounding and Bonding Requirements for Telecommunications.

All work and materials shall comply with the latest rules, codes and regulations, including but not limited to the following:

Occupational Safety and Health Act Standards (OSHA)
NFPA 70 - National Electrical Code (NEC)
ANSI/IEEE C-2 National Electrical Safety Code
All other applicable Federal, State, and local laws and regulations.

NFPA 70, Article 250 - Grounding

IEEE Standard 142 (Green Book) Recommended Practice for Grounding of Industrial and Commercial Power System.

IEEE Standard 1100 Power and Grounding Sensitive Electronic Equipment.

BONDING & GROUNDING INFRASTRUCTURE

IC (Interconnecting Bonding Conductor) (referred to in TIA/EIA-607 at the Bonding Conductor for Telecommunications): The copper conductor that bonds the TMGB to the service equipment (power) ground.

TMGB (Telecommunications Main Grounding Busbar): A copper ground reference busbar, typically installed in the entrance facility or entrance room, and is bonded to the service equipment (power) ground by the Interconnecting Bonding Conductor.

TGB (Telecommunications Grounding Busbar): A copper ground reference busbar, typically installed in telecommunication closets (TC) and is bonded to the TMGB by the TBB. The TGB references metallic entities in the TC space to ground.

TBB (Telecommunications Bonding Backbone): An insulated copper conductor extending from the TMGB to each TGB.

EK (Equipment Bonding Conductor): An insulated copper conductor that bonds metallic items and equipment to the TMGB and TGB.

products

MATERIALS

Refer to the General Conditions, Supplementary General Conditions, and Division-1 General Requirements.

Equipment Rack Busbars

Acceptable Manufactures: Newton Instrument Company (Figure 4028) 1/4" x 1" x 19" rack ground bar detail, for equipment rack applications.

Other Ground Reference Busbars

Acceptable Manufactures: Newton Instrument Company (Figure 3059) 1/4" x 1" x 12" insulated copper bar, for miscellaneous applications.

Bonding Conductors

All bonding conductors shall be insulated copper. Exception is use of flat, braided, aluminum ground straps utilized for bonding sections of aluminum cable tray.

Unless otherwise specified, size the conductors as required by NEC.

Unless otherwise specified, the TBB (Telecommunications Bonding Backbone) shall be insulated, copper, No. 3/0 AWG.

Unless otherwise specified, the EK (Equipment Bonding Conductor) shall be green-colored insulation, copper, No. 6 AWG.

Bonding Conductor Terminations

Acceptable Manufacturers: Thomas and Betts, ILSCO, or approved equal.

Acceptable materials:

Two hole compression lugs: Thomas and Betts, "Two Hole Lugs Long Barrel Type" color code blue (example catalogue No. 54816BE), high conductivity wrought copper, electro tin plated, or approved equal.

One hole compression lugs: Thomas and Betts, "Long Barrel One Hole Lugs" color code blue (example catalogue No. 54905BE), high conductivity wrought copper, electro tin plated, or approved equal.

GENERAL GROUNDING

Manufacturers of grounding and bonding products and equipment shall be firms regularly engaged in manufacture of these devices, of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than five years.

Material and installation shall comply with NEC requirements as applicable to construction and installation of electrical grounding equipment and systems.

Material and installation shall comply with National Electrical Contractors Association's "Standard of Installation" pertaining to the installation, grounding and bonding of electrical systems, circuits and equipment.

The Contractor shall provide electrical components which are UL-listed and labeled for each particular installation.

Except as otherwise indicated, provide electrical grounding and bonding systems indicated; with assembly of materials, including, but not limited to, cables/conductors/wires, connectors, solderless lug terminals, grounding electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for a complete and operational installation. Where more than one type component product meets indicated requirements, selection is Installer's Code-compliant option. Where materials or components are not indicated, provide products which comply with NEC, UL, and IEEE requirements and with established industry standards for those applications indicated.

Unless otherwise indicated, provide electrical grounding conductors for grounding system connections that match power supply wiring materials and are sized according to NEC.

All conduit systems, boxes, electrical equipment enclosures, motor frames, etc., shall be grounded in accordance with the requirements of the National Electrical Code, local authorities and as specified herein.

All grounding wires shall be copper and shall be sized in accordance with the latest edition of N.E.C.

All outlet boxes and junction boxes, disconnects, etc. shall be grounded. The ground wire terminal of each device shall be connected to the grounding conductor. All enclosures for electrical distribution and controls, all metal equipment supports for electrical controls and all similar items shall be connected to the grounding system.

All cable lugs for terminating grounding conductors number 6 AWG and larger, and as called for on drawings, shall be two hole hydraulic crimp compression type lugs connected to cable with a hydraulic compression tool. Each lug shall be connected to grounding bar or termination with two bolts plus "Belleville" type washers each side and nuts.

ELECTRICAL SYSTEM AND EQUIPMENT GROUNDING

All products shall be UL listed and labeled.

Ground conductors shall be 98% conductivity copper, either tinned bare or with green THWN-2 insulation. Other conductor requirements shall be the same as described for low voltage, 600 volt conductors.

Ground Connections:

Splices and Taps:

Thermoweld - utilize smokeless single shot exothermic connections for solid wire inside. Standard exothermic process may be used outside.

Compression - Solid long barrel copper, compressed with appropriate tool recommended by connector manufacturer. Use compression connections for stranded wire only.

Lugs:

Solid Wire - Use Thermoweld lug (smokeless inside) with two bolt tongue

Stranded Wire - Use solid long barrel copper sleeve, crimp type compression connector, with two bolt tongue, compressed with appropriate tool recommended by connector manufacturer.

Thoroughly clean connection surfaces prior to installation of clamps and/or lugs.

Where mechanical connections are unavailable, i.e. pipe clamps, et al, use bolted bronze mechanical connectors. Do not use clip-on connections.

Piping and conduit clamps: Use Burndy "GAR" or Penn Union type GPL, (no substitution unless accepted equivalent), size as required for piping

Seal connections between dissimilar metals (i.e.: bronze to steel), with "No-OXID-A" compound as manufactured by Dearborn Chemical Company.

INTERIOR EXPOSED GROUNDING CABLES

All exposed ground conductors shall be green in color.

All grounding conductors installed on cable tray or ladder rack shall be secured using the “KC Stitch” with approved cloth string.

Ground conductors connected to structure shall be connected with non-metallic approved fasteners.

Reference section 260519 for conductor types used for exposed ground wires. Interior telecommunications grounds shall not be ran in conduit and shall be fixed to the structure with approved non-metallic straps.

GROUNDING ELECTRODE AND REFERENCE GROUND SYSTEM

Ground Conductors

Interior (exposed): Bare stranded tinned copper or green insulated copper, size as shown.

Ground Connections

Buried and/or concealed inside building: Thermoweld process.

Interior Exposed wire connection requirements:

Solid Wire: Use smokeless thermolwelded connections for solid wire as shown.

Stranded Wire: Use Solid, long barrel copper connectors, compressed with appropriate tool recommended by connector manufacturer. Use compression connectors for stranded wire only.

Where exposed taps are made to stranded conductor interior ground rings, use wrought copper, split C tap copper compression taps or accepted equivalent.

Lugs: Solid wire to bus - Use Thermolwelded copper lug with two bolt tongue

Stranded wire to bus - Use long barrel copper sleeve, two-hole compression connector, with two bolt tongue

Piping Connections: Heavy cast bronze or copper equivalent to Burndy GAR or Penn Union GPL (no substitution)

Stranded wire to solid wire - use thermoweld connection

Preparation and Seal: Clean all connection surfaces and coat connection surfaces with "No-Oxide A" compound as manufactured by Dearborn Chemical Company.

Install all compression connectors with hydraulic compression tools recommended by manufacturer of connector to provide correct circumferential pressure. Provide embossing die code to make a visible indication that a connector has been adequately compressed on grounding conductor.

Ground Busses: 1/4" thick solid, hard drawn copper drilled as shown. Provide 2" ± stand off insulators, G.E. Benelex, (3/8" bolt size). Provide pre-drilled holes, to accommodate 3/8" bolts on 1" centers. See Details on drawing. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values.

execution

EXAMINATION

Examine areas and conditions under which electrical grounding and bonding connections are to be made and notify Contractor in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

Install electrical grounding and bonding systems as indicated, in accordance with manufacturer's instructions and applicable portions of NEC, NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products comply with requirements.

Coordinate with other electrical work as necessary to interface installation of electrical grounding and bonding system work with other work.

Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding. Submit torque actual torque values to the Architect for approval.

INSTALLATION

Bond ground conductors run in metal conduit to the conduit at all breaks and each end of run with full size conductor.

Coat all connections between dissimilar metals with "No-Oxid-A" compound as manufactured by Dearborn Chemical Company.

Bond all miscellaneous metal masses within 6' of the grounding conductor with #6 AWG copper conductor as shown.

In the Telecommunications Closets, Equipment Rooms, and Entrance Facilities provide all local bonding as specified on the drawings and in the specifications.

Ground electrical systems and equipment as required by code, utility, local ordinances, and requirements herein.

Cable connections and joints shall be provided per ANSI/TIA/EIA-607.

Bonding conductors should be continuous and routed in a direct route to point of termination.

All insulated ground bars must be isolated from the structural support by a 2” minimum separation, using manufacturer’s recommended insulating stand-offs and hardware.

Clean ground bars prior to terminating conductors.

Label all telecommunications bonding conductors as close as possible to their termination point.

Bond all TGBs to the TMGB using conductor size specified.

Bond the following to the TGB when present:

Telecommunication panelboards: ACEG, if equipped, or its enclosure.

TGBs within the same space

TBBs terminated on the same floor to other TGBs

Metallic equipment racks

Cable shields.

All metal raceways and cable trays for telecommunications cabling extending from the same room or space where the TGB is located.

Others as identified on the Drawings.

EK BONDING CONDUCTORS SHALL BE TERMINATED WITH ONE-HOLE COMPRESSION LUGS.

END OF SECTION 270526

SECTION 27 11 00 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data and Shop Drawings.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

D. Grounding: Comply with ANSI-J-STD-607-A.

E. Coordinate layout and installation of telecommunications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. Cable Support: NRTL labeled. Cable support brackets shall be designed to prevent degradation of cable performance and pinch points that could damage cable. Cable tie slots for fastening cable ties to brackets.

B. Cable Trays: Metal, suitable for indoors and protected against corrosion by electroplated zinc galvanizing.

1. Basket Cable Trays: 6 inches wide and 2 inches deep. Wire mesh spacing shall not exceed 2 by 4 inches.
2. Trough Cable Trays: Nominally 6-inch width.

C. Conduit and Boxes: Comply with Division 26 Section "Common Work Results for Electrical."

1. Minimum Outlet Box Size: 2 inches wide, 3 inches high, 2-1/2 inches deep.

D. Backboards: 3/4 inch, 48 by 96 inches, fire-retardant-treated plywood.

2.2 GROUNDING

A. Comply with requirements in Division 26 Section "Common Work Results for Electrical" for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-A.

2.3 LABELING

A. Comply with TIA/EIA 606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and housing when so directed by service provider.

B. Install [underground] [buried] [aerial] pathways complying with recommendations in TIA/EIA-569-A, "Entrance Facilities" Article.

1. Install [underground] [buried] <Insert pathway> entrance pathway, complying with Division 26 Section "Common Work Results for Electrical."

3.2 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout, and installation of communications equipment rooms.

C. Cable Trays: Comply with the requirements in NEMA VE 2 and TIA/EIA-569-A-7.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."

B. Comply with TIA/EIA-569-A, Annex A, "Firestopping.

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.4 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A.

END OF SECTION 271100

SECTION 27 15 00 - COMMUNICATIONS HORIZONTAL CABLING

GENERAL

SUMMARY

This section includes specifications for twisted pair horizontal station cable, multi-pair copper riser cable, coaxial cable and optical fiber communications cable.

Contractor shall provide all Belden/CDT products.

REFERENCES

Category 6 requirements are found in the following the American National Standards Institute (ANSI) and Electronic Industries Association/Telecommunications Industry Association (EIA/TIA) Standards.

ANSI/TIA/EIA-568 - A Commercial Building Telecommunications Cabling Standard

ANSI/EIA/TIA-569 - Commercial Building Standard for Telecommunications Pathways and Spaces

ANSI/TIA/EIA-606 - Administration Standard for the Telecommunications Infrastructure of Commercial Buildings

CODE COMPLIANCE

All work and materials shall comply with the most recent rules, codes, and regulations, including but not limited to the following.

Occupational Safety and Health Act Standards (OSHA)

NFPA 70 - National Electrical Code (NEC)

ANSI/IEEE C-2 National Electrical Safety Code

All other applicable Federal, State, and local laws and regulations.

MANUFACTURER’S INSTRUCTIONS

When specified in specification sections, submit manufacturer’s printed instructions for delivery, storage, assembly, installation, adjusting, and finishing, in quantities specified for Shop Drawings and Equipment Brochures.

Unless otherwise stated, where installation requirements identified in Reference Standards conflict with the manufacturer’s recommendations, the more restrictive shall be apply.

Bring to the attention of the Owner and Engineer conflicts between manufacturer’s instructions and Contract Documents.

QUALITY ASSURANCE

Full compliance with engineered design and specifications is required.

Performance criteria specified in references cited in Paragraph 1.3 shall be met. Test data shall verify system performance.

PRODUCTS

MATERIALS

Refer to Division-1 and the General Provisions of the Contract.

OWNER shall furnish all Belden/CDT materials. Contractor shall provide all other materials. Contractor shall provide the owner with an estimate of the quantities of the required Belden/CDT materials.

Communications Cables

Communications cables shall be type and size (number of pairs) identified for the installation of the various communications systems.

Communications cables shall be UL Listed and Approved for intended use. All cable shall be of Type specified by the NEC for use in plenum, non-plenum, and riser spaces.

Communications cables installed in cable trays or racks shall be APPROVED for use in such and shall be of fire-resistive construction.

Communications cable suitable for use in ducts, plenum, and other space used for environmental air shall be UL Listed as being smoke resistant, shall be Teflon-coated and shall be classified as type CMP communications cable.

Communications cable suitable for use in vertical shafts shall be UL Listed for use in such space and shall be classified as type CMR communications cable.

Horizontal Station Cable

Shielded Twisted Pair (STP)

Acceptable Manufacturers: Belden

Plenum Rated: DataTwist 53 ScTP Cable, TIA/EIA-568-B.2, Category 53 Nonbonded-Pair Cables with FEP Teflon insulation and Flamarrest Jacket, colors as designated by Owner.

Non Plenum Rated: DataTwist 53 ScTP Cable, TIA/EIA-568-B.2, Category 53 Nonbonded-Pair Cables with Polyolefin insulation and PVC Jacket, colors as designated by Owner.

Unshielded Twisted Pair (UTP)

Acceptable Manufacturers: Belden

Plenum Rated: DataTwist 600e UTP Cable, TIA/EIA-568B.2-1, Category 6, Enhanced Category 6 Bonded Pair Cables with FEP Teflon insulation and Flamarrest jacket, colors as designated by Owner.

Non Plenum Rated: DataTwist 600e UTP Cable, TIA/EIA-568B.2-1, Category 6, Enhanced Category 6 Bonded Pair Cables with Polyolefin insulation and PVC jacket, colors as designated by Owner.

Optical fiber

Plenum Rated: Provide plenum rated multimode grade 6 fiber, exceeding TIA/EIA-568-B.3-1 and ISO 11801 OM3, 50/125 µm aqua PVDF jacket. Provide SC, LC, and ST connectors as indicated on the drawings.

Copper Riser Cable

Shielded Twisted Pair (STP)

Acceptable Manufacturers: Belden

Plenum Rated: DataTwist 53 ScTP Cable, TIA/EIA-568-B.2, Category 53 Nonbonded-Pair Cables with FEP Teflon insulation and Flamarrest Jacket, colors as designated by Owner.

Non Plenum Rated: DataTwist 53 ScTP Cable, TIA/EIA-568-B.2, Category 53 Nonbonded-Pair Cables with Polyolefin insulation and PVC Jacket, colors as designated by Owner.

Unshielded Twisted Pair (UTP)

Acceptable Manufacturers: Belden

Plenum Rated: DataTwist 600e UTP Cable, TIA/EIA-568B.2-1, Category 6, Enhanced Category 6 Bonded Pair Cables with FEP Teflon insulation and Flamarrest jacket, colors as designated by Owner.

Non Plenum Rated: DataTwist 600e UTP Cable, TIA/EIA-568B.2-1, Category 6, Enhanced Category 6 Bonded Pair Cables with Polyolefin insulation and PVC jacket, colors as designated by Owner.

Cable Bundling Hardware

Acceptable manufacturers: Panduit, Velcro Brand, Tyton, U.G. Products Company, Chatsworth Products Incorporated, Great Lakes Case and Cabinet Company, or approved equal.

Construction: Re-usable adjustable, cable straps, capable of withstanding fastening to wall with screws, or equipped with snap-and-button fasteners. White color is preferable, else black color. With and without cinch ring as applicable.

Innerduct

Acceptable Manufactures: Pyramid and Carlon

Plenum Rated: Indoor Corrugated Innerduct, Pyramid P/N PLM100T or equivalent

Non Plenum Rated: Indoor Corrugated Innerduct, Carlon P/N 14108R or equivalent

EXECUTION

COPPER CABLE INSTALLATION

Requirements of Paragraph 3.1 apply to all cables.

Install all cables through primary and secondary pathways. Unless otherwise specified, installation methods and techniques shall satisfy ANSI/EIA/TIA-569, Commercial Building Standard for Telecommunications Pathways and Spaces.

Where cables are supported from building structure they shall be adequately supported such that the cable will not be damaged by normal building use.

Horizontal station cables shall be home-run from the communication outlet box at the work area to the distribution frame serving the area as shown on the Drawings.

Cables shall not be installed or routed in any manner that violates the manufacturer's specifications. Manufacturer's minimum bend radius for static (post installation) cables is 10 times the cable diameter. Manufacturer's minimum bend radius for cables under strain (pulling tension) is 20 times the cable diameter.

Unless otherwise specified, terminate cables in accordance with ANSI/TIA/EIA-568-A, Commercial Building Telecommunications Cabling Standard, observing the industry standards for terminating color-coded cables for premises and campus environments.

Do not install damaged or defective cable.

Installed damaged cable will not be accepted. Unless otherwise allowed by the Owner, damaged cable shall be removed and new cable installed at the expense of the Contractor. Damage includes physical damage to the cable and damage that may affect performance. THE OWNER WILL NOT ACCEPT CABLE OF ANY TYPE UNTIL AFTER IT IS INSTALLED AND PASSES A PHYSICAL INSPECTION AND ALL PERFORMANCE TESTS.

The Contractor shall field survey and review with the Owner and Engineer similar installations on site that contain the same type of materials that are used for this Project to gain the desired routing and layout, installation techniques, and finished-look prior to start of construction and as often as necessary during the construction process.

Cable Support Along Primary Pathway

Primary pathways include major pathways for cable routed floor-to-floor, through corridors, and pathways that carry cables feeding multiple areas which are likely to be used to support growth in those areas. Primary pathways carry cable to secondary pathways.

Where cable tray cannot be installed to be continuous, provide support and strain relief for cables using mechanical fasteners such as J-hooks, conduit, C-channel, and other necessary devices to support cables around discontinuity. In exposed areas support cables as indicated on Drawings.

Where a telecommunication raceway, cable tray, or cable rack is provided, all telecommunication cables shall utilize the system except:

Emergency system wiring

Fire alarm systems

Cables shall be routed to avoid cable crossover between cable continuing vertically floor-to-floor and cable routed horizontally.

Cable installation and cable routes shall be planned and cables shall be installed such that the capacity of the conduit, sleeves, and cable tray is used most efficiently.

Bundle and route cables throughout the building to maintain neat, uniform, and combed bundles. Where cable is exposed in vertical runs, such as utility shafts, provide reusable cable straps to neatly contain cable bundles.

Provide strain relief for cables routed vertically using mechanical fasteners such as conduit, C-channel, reusable cable straps, other necessary devices to support cables.

Cable Support Along Secondary Pathway

Secondary pathways extend from the primary pathway to the communication outlet box. Secondary pathways carry cable from the primary pathway to the communication outlet box.

Cable shall be routed parallel and perpendicular to walls and floor from the primary pathway to the outlet box. WHERE MULTIPLE ROUTES ARE POSSIBLE, ROUTE CABLE ALONG THE SHORTEST ROUTE TO MINIMIZE CABLE LENGTH AS PRACTICABLE.

Do not use suspended ceiling support hangers (wires) to support station cables.

Do not support cable from other mechanical, electrical, or plumbing, systems.

Station cables shall be supported such that they do not rest on the suspended ceiling system.

Cables and cable pathways shall be supported from the building structure. Superstructure designed and intended to support multiple utilities may be used as a superstructure for communications cables if the superstructure can physically support the additional load and if the support mechanism for the cable works for supporting the cable from the superstructure.

CABLE BUNDLING HARDWARE

Cable bundling hardware shall be rated for the environment and application in which used. Applications include, but are not limited to, general purpose, outdoor, chemical resistant, flame retardant, high temperature, and vibration.

Provide reusable cable management straps for bundling and securing horizontal station cables and equipment jumper cables within entrance facilities and telecommunication closets. Do not use nylon cable ties.

Provide reusable cable management straps for bundling and securing horizontal station cables at primary vertical pathways. Do not use nylon cable ties.

Do NOT strap horizontal station cable to cable tray and ladder rack.

CROSS-CONNECT JUMPERS

Owner will install all cross-connect jumpers.

Provide 2” minimum and 4” maximum service loop in each cross-connect jumper for voice and data circuits at each end.

Cross-connect jumpers shall be uniform in shape.

Plan and route cross-connect jumpers for voice circuits and data circuits through the jumper rings on the frames such that they are not intermixed haphazardly. Keep voice and data cross-connect jumpers segregated as possible.

CABLE MANAGEMENT AND ROUTING AT DISTRIBUTION FRAMES

At distribution frames route cables along the backboard vertically and horizontally to avoid diagonal routing. Where the termination location is unspecified, neatly coil enough cable slack in each closet to reach the farthest corner of the backboard routing vertically and horizontally.

Plan cable layout, routing, and cable management on the backboard such that:

Cable cross-over is minimal.

Cables are kept as short as practicable.

Station cables and equipment cables are neatly shaped, combed, and bundled vertically and horizontally.

COPPER CABLE SPLICES

Horizontal station cables shall not be spliced.

Splices in backbone cables shall be made using mechanical tools, modules, and connectors of the same manufacturer which are specifically designed for the type and size of cable being spliced.

All splices shall be performed in a splice closure specifically designed for the number of cables, size of cables, quantity of conductors, and environment of the splice.

Metallic shields of telecommunications cables shall be bonded together within the closure of all splices.

All cables entering a splice case shall be supported independent of the splice case to a supporting structure and such that the splice case is accessible for re-entry.

Splicing of cables containing energized circuits shall be coordinated with Owner.

CABLE REMOVAL

All copper riser cable, horizontal station cable, and termination hardware that is replaced with new shall be removed.

Existing twisted pair communications cable and hardware in the project area that has been abandoned in place prior to this Project shall be removed.

Conduit and enclosures shall remain. Blank covers shall be provided for abandoned outlet boxes.

All penetrations and sleeves affected by removal of cable shall be fire-stopped after removal of cable to maintain required fire rating.

Existing termination hardware within the existing telecommunications spaces and communications enclosures shall be removed from service after cutover.

Existing distribution frame hardware and cabling shall be removed after active services are transferred to new cabling system as verified at frame.

OPTICAL CABLE INSTALLATION AND ROUTING

The optical fiber cable shall be installed after complete installation of the innerduct if innerduct is specified.

All optical fiber cable shall be home-run. Cables shall not be spliced.

The cable shall be installed in accordance with the manufacturer’s specifications for installation and loading. The short and long term cable loading values shall not be violated.

The manufacturer’s minimum bending radius under both loaded and unloaded conditions shall not be violated. Cable wrinkling shall be avoided.

Cable and innerduct routes shall be defined prior to installation such that the cable lengths are accurate, such that securing cable in place will not result in shortage of cable, and such that desired routing paths are not compromised because of inaccurate planning and coordination.

A service loop of 10 feet (minimum) shall be provided at both ends of the cable unless otherwise indicated on the drawings. The location of the service loop shall be placed such that the cable can be extended without interference of other systems such as mechanical systems, electrical piping, plumbing, racking, etc. The direction of the loop (i.e., clockwise or counter-clockwise) shall be such that the cable enters the rack and distribution hardware with minimal bends. The service loop shall be stored out-of-way and fastened to prevent possible damage.

General Optical Fiber Termination

All Single-mode fiber shall be fusion spliced, fiber to fiber or fiber to factory made jumper with ST connectors. All Single-mode fiber will have ST connectors.

Backbone (multimode) optical fiber cables shall be directly terminated with SC composite/ceramic connector in accordance with the connector manufacturer’s recommendations. All Single-mode fiber will be fusion spliced to jumpers

Cable and fiber protection, installation, and termination shall be according to the connector manufacturer’s recommended practices and shall use the manufacturer’s kits, processes, cleaners, solvents, fasteners, and other mechanisms necessary for a complete termination unless otherwise indicated herein.

Unless otherwise indicated, all cable routing, management, preparation, protection, installation, and storage shall be according to the hardware manufacturer’s recommended practices and shall use the manufacturer’s kits, processes, cable and fiber management hardware, fasteners, and other mechanisms necessary for a complete installation.

The multimode fibers shall be terminated with a connector that is beige in color and shall be inserted into the adapter that is beige in color. The single-mode fibers shall be terminated with a connector that is blue in color and inserted into the adapter that is blue in color.

Cable and fiber terminations shall be labeled. Contractor shall provide information per Owner furnished cable recording documents.

Cable termination shall incorporate industry standard color coding and positioning within the enclosures. Refer to Paragraph 3.8.4 for adapter orientations.

The connector panels that contain the SC adapters shall accommodate six adapters (six fibers). See paragraph 3.8.4 for orientation of the adapters for desired polarity.

Fiber Termination Within Rack Mount Patch Panels

Coordinate with Owner and Engineer to field review the installation of enclosures and hardware to gain desired installation techniques and placement practices before their installation throughout campus buildings.

Install the Patch Panels as shown on the drawings. Unless otherwise shown, all enclosures shall be installed tight to each other in the equipment racks.

The Patch Panels shall be installed with connector panels in low density configuration.

Install Single-mode and Multimode fibers in separate Patch

Fiber Termination Adapter Orientation

Specific orientation of the adapters is necessary to maintain the correct polarity to transmit and receive signals throughout the site. Polarity is achieved by physical key slot orientation of adapters in the fiber distribution enclosures. The adapter orientation that shall be applied will be included with the fiber cable recording documents from the Owner and Engineer.

Physical orientation of the adapters shall be achieved by removing and rotating the adapter within the connector panel to the proper key-slot-up or key-slot-down.

WIRE AND CABLE IDENTIFICATION

Provide labels as specified in Section 270553.

END OF SECTION 271500

SECTION 27 15 10 – AV AND OTHER LOW VOLTAGE CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. UTP cabling.
2. OM3 50/125-micrometer, optical fiber cabling.
3. Coaxial cable.
4. Multiuser telecommunications outlet assemblies.
5. Cable connecting hardware, patch panels, and cross-connects.
6. Telecommunications outlet/connectors.
7. Cabling system identification products.
8. Cable management system.

B. Related Requirements:

1. Section 271300 "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
2. Section 280513 "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

E. LAN: Local area network.

F. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

G. RCDD: Registered Communications Distribution Designer.

H. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of telecommunications cabling with Owner's telecommunications and LAN equipment and service suppliers.

B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For coaxial cable, include the following installation data for each type used:

a. Nominal OD.
b. Minimum bending radius.
c. Maximum pulling tension.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. Cabling administration drawings and printouts.
3. Wiring diagrams to show typical wiring schematics, including the following:

a. Cross-connects.
b. Patch panels.
c. Patch cords.

4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

C. Samples: For workstation outlets, jacks, jack assemblies, in specified finish, one for each size and outlet configuration and faceplates for color selection and evaluation of technical features.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

B. Not Used

C. Not Used.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.

2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Not Used.

1. Not Used.
2. Not Used.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cables to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.
2. Test each pair of UTP cable for open and short circuits.

PART 2 - PRODUCTS

2.1 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.

1. TIA/EIA-568-B.1 requires that a minimum of three telecommunications outlet/connectors be installed for each work area.
2. Bridged taps and splices shall not be installed in the horizontal cabling.
3. Splitters shall not be installed as part of the optical fiber cabling.

B. The maximum allowable horizontal cable length is 295 feet (90 m). This maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) to the workstation equipment or in the horizontal cross-connect.

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1 when tested according to test procedures of this standard.

B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 450 or less.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Grounding: Comply with J-STD-607-A.

2.3 UTP CABLE

A. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Berk-Tek; a Nexans company.
2. CommScope, Inc.
3. SYSTIMAX Solutions; a CommScope, Inc. brand.
4. Panduit Corp.

C. Description: 100-ohm, four-pair UTP, formed into

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 6.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
    a. Communications, Plenum Rated: Type CMP or MPP, complying with NFPA 262.
    b. Communications, Limited Purpose: Type CMX; or MPP, CMP, MPR, CMR, MP, MPG, CM, or CMG.

2.4 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Panduit Corp.
2. Berk-Tek; a Nexans company.
3. CommScope, Inc.
4. SYSTIMAX Solutions; a CommScope, Inc. brand.

C. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

D. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

E. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

F. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair UTP cable indicated conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.

G. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

H. Patch Cords: Factory-made, four-pair cables in 48-inch lengths; terminated with eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

2.5 OPTICAL FIBER CABLE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Belden Inc.
2. Berk-Tek; a Nexans company.
3. CommScope, Inc.
4. Corning Cable Systems.
5. SYSTIMAX Solutions; a CommScope, Inc. brand.
6. Panduit Corp

C. Description: Multimode, OM3 50/125-micrometer, 12 -fiber, Armor, tight buffer, optical fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.

2. Comply with TIA/EIA-568-B.3 for performance specifications.
3. Comply with TIA-492AAAC for detailed specifications.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
   a. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
5. Maximum Attenuation: 3.0 dB/km at 850 nm; 1.0 dB/km at 1300 nm.
6. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

D. Jacket:

1. Jacket Color: Aqua for 50/125-micrometer cable.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-C.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.6 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Belden Inc.
2. Berk-Tek; a Nexans company.
3. CommScope, Inc.
4. Corning Cable Systems.
5. SYSTIMAX Solutions; a CommScope, Inc. brand.
6. Panduit Corp.

C. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

D. Patch Cords: Factory-made, dual-fiber cables in 36-inch lengths.

E. Cable Connecting Hardware:

1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA-604-2-B, TIA-604-3-B, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
2. Quick-connect, simplex and duplex, Type SC connectors. Insertion loss not more than 0.50 dB.

2.7 COAXIAL CABLE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Alpha Wire Company.
2. Belden Inc.
3. Coleman Cable, Inc.
4. CommScope, Inc.
5. Draka Cableteq USA.

C. Cable Characteristics: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.

D. RG-6/U: NFPA 70, Type CATV or CM.

1. No. 16 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
2. Double shielded with 100 percent aluminum-foil shield and 60 percent aluminum braid.
3. Jacketed with black PVC or PE.
4. Suitable for indoor installations.

E. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70 "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Types are as follows:

1. CATV Plenum Rated: Type CATVP, complying with NFPA 262.

2.8 COAXIAL CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Emerson Network Power Connectivity Solutions.
2. Leviton Commercial Networks Division.
3. Siemon Co. (The).

C. Coaxial-Cable Connectors: Type BNC, 75 ohms.

2.9 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.

B. Workstation Outlets: Three-port-connector assemblies mounted in single faceplate.

1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
2. Metal Faceplate: Stainless steel, complying with requirements in Section 262726 "Wiring Devices."
3. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.
    a. Flush mounting jacks, positioning the cord at a 45° angle.
4. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

2.10 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with J-STD-607-A.

2.11 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with requirements in Section 260553 "Identification for Electrical Systems."

2.12 CABLE MANAGEMENT SYSTEM

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. iTRACS Corporation, Inc.
2. TelSoft Solutions.

C. Description: Computer-based cable management system, with integrated database and graphic capabilities.

D. Document physical characteristics by recording the network, TIA/EIA details, and connections between equipment and cable.

E. Information shall be presented in database view, schematic plans, or technical drawings.

1. Microsoft Visio Professional or AutoCAD drawing software shall be used as drawing and schematic plans software.

F. System shall interface with the following testing and recording devices:

1. Direct upload tests from circuit testing instrument into the personal computer.
2. Direct download circuit labeling into labeling printer.

2.13 SOURCE QUALITY CONTROL

A. Test UTP cables according to TIA/EIA-568-B.2.

B. Test multimode optical fiber cables according to TIA-526-14-A and TIA/EIA-568-B.3.

C. Factory-sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters. Conceal pathways and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.

2. Comply with requirements in Section 270528 "Pathways for Communications Systems."
3. Comply with requirements in Section 270536 "Cable Trays for Communications Systems."

B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures:

1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
2. Install lacing bars and distribution spools.
3. Install conductors parallel with or at right angles to sides and back of enclosure.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.

4. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
10. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-B.3.
2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-B, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.5 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.

B. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.

C. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

D. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 Class 3 Class 4 level of administration, including optional identification requirements of this standard.

E. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow

convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.

G. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
    a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.

1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections:

1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
2. Visually confirm Category 6, marking of outlets, cover plates, outlet/connectors, and patch panels.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

5. Optical Fiber Cable Tests:
    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:
        1) One hundred percent of the cable's fiber count shall be tested with an Optical Time Domain Reflectometer (OTDR) at 850 nm and 1300 nm in addition; an Optical Loss Test Set (OLTS) shall be used to test the fiber. The contractor shall provide the Engineer with up to five copies of any software required for viewing electronic files of the OLTS and OTDR traces. Use a EXFO FTB-500 or equal OTDR meter and a Fluke DTX-CLT or equal OLTS meter.
        2) All test equipment shall be factory certified within the last year. The Contractor shall provide copies of the certification 10 days prior to testing.
        3) Test results will be recorded on a form supplied by the Contractor and approved by the Engineer, with data compiled and printed through the meter manufacture's software. No additional alternation using software from the Contractor beyond this software will be allowed. Prior to testing the Contractor shall submit a sample form to the Engineer. Completed test forms on each fiber shall be handed over to the Engineer. At a minimum, test results shall show the following:
            a) Cable and fiber identification
            b) Operator name
            c) Engineer
            d) Date and Time
            e) Setup and test parameters including wavelength, pulse width, range, scale and ambient temperature.
            f) Test results for OTDR test averaged for total fiber trace, splice loss/gain (dB), connector loss (dB), all events greater than .05 dB, measured length from cable markings and total length from OTDR.
            g) Test results for attenuation test including measured cable length (cable marking) total length (from OTDR test) number of splices (from as-builts) and total link attenuation versus allowed attenuation.
        4) OTDR testing shall use a launch and receiving cables minimum 500 meters or greater than the dead zone for the OTDR used for this test.
        5) All fiber connectors must be cleaned and checked for dirt, scratches or chips before installed in adapters and testing. All dust covers must be installed after testing is complete.
        6) The objective for all fiber optic cable is to have a maximum attenuation of 3.0 dB/km at 850 nm and 1.0 dB/km at 1300 nm when measured bi-directionally with an OTDR or OTLS. Fibers that exceed the max attenuation loss specification will be identified as Out Of Specification (OOS) and subject to penalties of $150.00 of each OOS trace.

7) The objective for each connector is an averaged loss value of 0.25 dB or less when measured with an OTDR at 850 nm and 1300 nm. Fibers not meeting the max loss of 0.5 dB average 0.25 dB (no negative losses will be accepted) specification will be identified as Out Of Specification (OOS) and subject to penalties of $150.00 of each OOS trace.
8) The objective for each splice is an averaged loss value of 0.07 dB or less when measured bi-directionally with an OTDR at 850 nm and 1300 nm. Fibers not meeting the 0.10 dB or less specification will be identified as Out Of Specification (OOS) and subject to penalties of $150.00 of each OOS trace.
9) Remove malfunctioning units, replace with new units, and retest as specified above.

6. UTP Performance Tests:
    a. Test for each outlet. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:
        1) Wire map.
        2) Length (physical vs. electrical, and length requirements).
        3) Insertion loss.
        4) Near-end crosstalk (NEXT) loss.
        5) Power sum near-end crosstalk (PSNEXT) loss.
        6) Equal-level far-end crosstalk (ELFEXT).
        7) Power sum equal-level far-end crosstalk (PSELFEXT).
        8) Return loss.
        9) Propagation delay.
        10) Delay skew.
7. Optical Fiber Cable Performance Tests: Perform optical fiber end-to-end link tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.3.
8. Coaxial Cable Tests: Conduct tests according to Section 274133 "Master Antenna Television System."
9. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.
    a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
    b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

D. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.8 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two (2) years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
    1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets

END OF SECTION 271500

SECTION 28 05 00 - COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Submittals: Product Data.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 SLEEVES FOR PATHWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized-steel sheet.

D. Sleeve Seals: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Stainless steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.02 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.01 GENERAL ELECTRONIC SAFETY AND SECURITY EQUIPMENT INSTALLATION REQUIREMENTS

A. Install electronic safety and security equipment to allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.

B. Install electronic safety and security equipment to provide for ease of disconnecting the equipment with minimum interference to other installations.

C. Install electronic safety and security equipment to allow right of way for piping and conduit installed at required slope.

D. Install electronic safety and security equipment to ensure that connecting pathways and cables are clear of obstructions and of the working and access space of other equipment.

E. Install required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

F. Coordinate location of access panels and doors for electronic safety and security items that are behind finished surfaces or otherwise concealed. Comply with requirements in Division 08 Section "Access Doors and Frames."

G. Install sleeve and sleeve seals of type and number required for sealing electronic safety and security service penetrations of exterior walls.

3.02 SLEEVE AND SLEEVE-SEALS INSTALLATION

A. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

B. Cut sleeves to length for mounting flush with both wall surfaces.

C. Extend sleeves installed in floors 2 inches above finished floor level.

D. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and cable unless sleeve seal is to be installed [or unless seismic criteria require different clearance].

E. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies].

F. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 07 Section "Joint Sealants."

G. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.

H. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

I. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between cable and sleeve for installing mechanical sleeve seals.

3.03 FIRESTOPPING

A. Apply firestopping to electronic safety and security penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Comply with requirements in Division 07 Section "Penetration Firestopping."

END OF SECTION 280500

SECTION 28 05 13 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.01 SECTION REQUIREMENTS

A. Submittals: Product Data and Shop Drawings.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 2 - PRODUCTS

2.01 PATHWAYS

A. Support of Open Cabling: NRTL labeled for support of cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

B. Cable Trays: Metal, suitable for indoors, and protected against corrosion by electroplated zinc galvanizing.

1. Basket Cable Trays: 12 inches wide and 2 inches deep. Wire mesh spacing shall not exceed 2 by 4 inches
2. Trough Cable Trays: Nominally 6-inch width.

C. Conduit and Boxes: Comply with Division 26 Section 260500 "Common Work Results for Electrical."

1. Minimum Outlet Box Size: 2 inches wide, 3 inches high, 2-1/2 inches deep.

D. Backboards: 3/4 inch by 48 by 96 inches fire-retardant-treated plywood.

2.02 UTP CABLE

A. Description: 100 ohm, four-pair UTP, covered with a blue thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 6.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

a. Communications, General Purpose: Type CM or CMG
b. Communications, Plenum Rated: Type CMP complying with NFPA 262.
c. Communications, Riser Rated: Type CMR complying with UL 1666.

B. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.

C. Connecting Blocks: 110-style for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

2.03 OPTICAL-FIBER CABLE

A. Description: Multimode, 62.5/125 micrometer, 12 fibers, nonconductive, tight buffer, optical-fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA/EIA-568-B.3 for performance specifications.
3. Comply with TIA-492AAAA-A for detailed specifications.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
    a. General Purpose, Nonconductive: Type OFN or OFNG
    b. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
    c. Riser Rated, Nonconductive: Type OFNR complying with UL 1666.

B. Jacket:

1. Jacket Color: Orange for 62.5/125-micrometer cable.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-C.

C. Cable Connecting Hardware: Meet the Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA-604-2-B, TIA-604-3-B, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.

1. Quick-connect, simplex and duplex, Type SC connectors. Insertion loss not more than 0.75 dB.
2. Type SFF connectors may be used in termination racks, panels, and equipment packages.

2.04 COAXIAL CABLE

A. General Coaxial Cable Requirements: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.

B. RG-11/U: NFPA 70, Type CATV.

1. No. 14 AWG, solid, copper-covered steel conductor.
2. Gas-injected, foam-PE insulation.
3. Double shielded with 100 percent aluminum polyester tape and 60 percent aluminum braid.
4. Jacketed with sunlight-resistant black PVC or PE.

5. Suitable for outdoor installations in ambient temperatures ranging from minus 40 to plus 85 deg C.

C. RG-6/U: NFPA 70, Type CATV or CM.

1. No. 16 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
2. Double shielded with 100 percent aluminum-foil shield and 60 percent aluminum braid.
3. Jacketed with black PVC or PE.
4. Suitable for indoor installations.

D. NFPA and UL Compliance: CATV Cable, Type CATV, or CATVP or CATVR shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655, and with NFPA 70 "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" articles.

E. Coaxial-Cable Connectors: Type BNC, 75 ohms.

2.05 RS-232 CABLE

A. Standard Cable: NFPA 70, Type CM.

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Polypropylene insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. PVC jacket.
5. Pairs shall be cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
6. Flame Resistance: Comply with UL 1581.

B. Plenum-Type Cable: NFPA 70, Type CMP.

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Plastic insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. Plastic jacket.
5. Pairs shall be cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
6. Flame Resistance: Comply with NFPA 262.

2.06 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CM or CMG.

1. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262, Flame Test.

2.07 LOW-VOLTAGE CONTROL CABLE

A. Paired Lock Cable: NFPA 70, Type CMG.

1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

B. Plenum-Type, Paired Lock Cable: NFPA 70, Type CMP.

1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

2.08 CONTROL CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, complying with UL 83, in raceway

B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, complying with UL 83, in raceway

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or TF, complying with UL 83.

2.09 FIRE-ALARM WIRE AND CABLE

A. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

B. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG or size as recommended by system manufacturer.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70 Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.

C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75°C, color-coded insulation.

1. Low-Voltage Circuits: No. 16 AWG, minimum.
2. Line-Voltage Circuits: No. 12 AWG, minimum.
3. Multi-conductor Armored Cable: NFPA 70 Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NTRL listed for fire-alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

2.010 IDENTIFICATION PRODUCTS

A. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.01 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.

B. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

C. Comply with requirements in Division 26 Section "Common Work Results for Electrical." for installation of conduits and wireways.

D. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.02 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Division 26 Section 060500, "Common Work Results for Electrical."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

3.03 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
4. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation: Comply with TIA/EIA-568-B.2.

D. Optical-Fiber Cable Installation: Comply with TIA/EIA-568-B.3. Terminate cables on connecting hardware that is rack or cabinet mounted.

E. Outdoor Coaxial Cable Installation:

1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches.

F. Open Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Do not install cables through structural members or in contact with pipes, ducts, or other potentially damaging items.

G. Separation from EMI Sources: Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment. Comply with the following minimum separation distances from possible sources of EMI:

1. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches

2. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches

3. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches
4. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches
5. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches

3.04 FIRESTOPPING

A. Firestopping: Comply with requirements in Division 07 Section "Penetration Firestopping."

B. Comply with TIA-569-B, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.05 GROUNDING

A. For communications wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. For low-voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.06 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A.

END OF SECTION 280513

SECTION 28 46 21.11 - NEW ADDRESSABLE FIRE ALARM SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Fire alarm system as shown on plans and herein specified.
2. Cable and conduit for a complete operating system.
3. System smoke detectors.
4. Notification appliances.
5. Addressable interface device.
6. Digital alarm communicator transmitter.
7. Connections to elevator systems.
8. Fire alarm acceptance testing.

1.02 SYSTEM DESCRIPTION

A. This section of the specification includes the furnishing, installation, connection and testing of the microprocessor controlled, intelligent reporting fire alarm equipment required to form a complete, operative, coordinated system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, Fire Alarm Control Panel (FACP), auxiliary control devices, annunciators, and wiring as shown on the drawings and specified herein.

B. The fire alarm system shall comply with requirements of NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.

C. The fire alarm system shall be manufactured by an ISO 9001 certified company and meet the requirements of BS EN9001: ANSI/ASQC Q9001-1994.

D. The FACP and peripheral devices shall be manufactured 100% by a single U.S. manufacturer (or division thereof).

E. The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and the installation shall be in compliance with the UL listing.

F. The installing company shall employ NICET (minimum Level II Fire Alarm Technology) technicians on site to guide the final checkout and to ensure the systems integrity

G. Noncoded, addressable system, with multiplexed signal transmission, dedicated to fire-alarm service only.

1.03 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.04 SUBMITTALS

A. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:

    a. Trained and certified by manufacturer in fire-alarm system design.

B. Product Data: For each type of product indicated.

C. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.

1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
2. Include voltage drop calculations for notification appliance circuits.
3. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
4. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

D. Qualification Data: For qualified Installer.

E. Seismic Qualification Certificates: For fire-alarm control unit, accessories, and components, from manufacturer.

F. Field quality-control reports.

G. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
3. Record copy of site-specific software.
4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
    a. Frequency of testing of installed components.
    b. Frequency of inspection of installed components.
    c. Requirements and recommendations related to results of maintenance.
    d. Manufacturer's user training manuals.
5. Manufacturer's required maintenance related to system warranty requirements.
6. Copy of NFPA 25.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II technician.

C. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system if applicable.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Notifier NFS-320 / NFS2-640 addressable control panel (depending on # of nodes)
2. Simplex 4100U addressable control panel
3. Honeywell
4. GE – Edwards

2.02 CONDUIT AND WIRE

Conduit:

1. Conduit shall be in accordance with The National Electrical Code (NEC), local and state requirements.
2. Where required, all wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross-sectional area where three or more cables are contained within a single conduit.
3. Cable must be separated from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, per NEC Article 760-55.
4. Wiring for 24-volt DC control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.

5. Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.
6. Conduit shall be 3/4-inch (19.1 mm) minimum.
7. Conduit for fire alarm system shall be red.

Wire:

1. All fire alarm system wiring shall be new.
2. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for Initiating Device Circuits and Signaling Line Circuits, and 14 AWG (1.63 mm) for Notification Appliance Circuits.
3. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
4. Wire and cable not installed in conduit shall have a fire resistance rating suitable for the installation as indicated in NFPA 70 (e.g., FPLR).
5. Wiring used for the multiplex communication circuit (SLC) shall be twisted and unshielded and support a minimum wiring distance of 12,500 feet. The design of the system shall permit use of IDC and NAC wiring in the same conduit with the SLC communication circuit.
6. All field wiring shall be electrically supervised for open circuit and ground fault.
7. The fire alarm control panel shall be capable of t-tapping Class B (NFPA Style 4) Signaling Line Circuits (SLCs). Systems that do not allow or have restrictions in, for example, the amount of t-taps, length of t-taps etc., are not acceptable.

Terminal Boxes, Junction Boxes and Cabinets:

1. All boxes and cabinets shall be UL listed for their use and purpose.

Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted except on signaling line circuits connected to intelligent reporting devices.

The fire alarm control panel shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit shall be labeled at the main power distribution panel as FIRE ALARM. Fire alarm control panel primary power wiring shall be 12 AWG. The control panel cabinet shall be grounded securely to either a cold-water pipe or grounding rod.

2.03 MAIN FIRE ALARM CONTROL PANEL OR NETWORK NODE

A. Main FACP or network node shall contain a microprocessor based Central Processing Unit (CPU) and power supply in an economical space saving single board design. The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, printer, annunciators, and other system-controlled devices.

B. Operator Control

1. Acknowledge Switch:

   a. Activation of the control panel acknowledge switch in response to new alarms and/or troubles shall silence the local panel piezo electric signal and change the alarm and trouble LEDs from flashing mode to steady-ON mode. If multiple alarm or trouble conditions exist, depression of this switch shall advance the LCD display to the next alarm or trouble condition.
   b. Depression of the Acknowledge switch shall also silence all remote annunciator piezo sounders.

2. Alarm Silence Switch:
   a. Activation of the alarm silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition after an alarm condition. The selection of notification circuits and relays that are silenceable by this switch shall be fully field programmable within the confines of all applicable standards. The FACP software shall include silence inhibit and auto-silence timers.

3. Alarm Activate (Drill) Switch:
   a. The Alarm Activate switch shall activate all notification appliance circuits. The drill function shall latch until the panel is silenced or reset.

4. System Reset Switch:
   a. Activation of the System Reset switch shall cause all electronically-latched initiating devices, appliances or software zones, as well as all associated output devices and circuits, to return to their normal condition.

5. Lamp Test:
   a. The Lamp Test switch shall activate all local system LEDs, light each segment of the liquid crystal display and display the panel software revision for service personal

C. System Capacity and General Operation

1. The control panel or each network node shall provide or be capable of expansion to 636 intelligent/addressable devices.
2. The control panel or each network node shall include Form-C alarm, trouble, supervisory, and security relays rated at a minimum of 2.0 amps @ 30 VDC.
3. It shall also include four Class B (NFPA Style Y) or Class A (NFPA Style Z) programmable Notification Appliance Circuits
4. The Notification Appliance Circuits shall be progammable to Syncronize with System Sensor, Gentex and Wheelock Notification Appliances.
5. The system shall include a full featured operator interface control and annunciation panel that shall include a backlit Liquid Crystal Display (LCD), individual color coded system status LEDs, and an alphanumeric keypad with easy touch rubber keys for the field programming and control of the fire alarm system.
6. The system shall be programmable, configurable, and expandable in the field without the need for special tools, PROM programmers or PC based programmers. It shall not require replacement of memory ICs to facilitate programming changes.
7. The system shall allow the programming of any input to activate any output or group of outputs. Systems that have limited programming (such as general alarm), have complicated programming (such as a diode matrix), or require a laptop personal computer are not considered suitable substitutes.
8. The FACP shall support up to 20 logic equations, including "and," "or," and "not," or time delay equations to be used for advanced programming. Logic equations shall require the use of a PC with a software utility designed for programming.
9. The FACP or each network node shall provide the following features:

a. Drift compensation to extend detector accuracy over life. Drift compensation shall also include a smoothing feature, allowing transient noise signals to be filtered out.
b. Detector sensitivity test, meeting requirements of NFPA 72, Chapter 7.
c. Maintenance alert, with two levels (maintenance alert/maintenance urgent), to warn of excessive smoke detector dirt or dust accumulation.
d. Nine sensitivity levels for alarm, selected by detector. The alarm level range shall be .5 to 2.35 percent per foot for photoelectric detectors and 0.5 to 2.5 percent per foot for ionization detectors. The system shall also support sensitive advanced detection laser detectors with an alarm level range of .03 percent per foot to 1.0 percent per foot. The system shall also include up to nine levels of Prealarm, selected by detector, to indicate impending alarms to maintenance personnel.
e. The ability to display or print system reports.
f. Alarm verification, with counters and a trouble indication to alert maintenance personnel when a detector enters verification 20 times.
g. PAS presignal, meeting NFPA 72 3-8.3 requirements.
h. Rapid manual station reporting (under 3 seconds) and shall meet NFPA 72 Chapter 1 requirements for activation of notification circuits within 10 seconds of initiating device activation.
i. Periodic detector test, conducted automatically by the software.
j. Self optimizing pre-alarm for advanced fire warning, which allows each detector to learn its particular environment and set its pre-alarm level to just above normal peaks.
k. Cross zoning with the capability of counting: two detectors in alarm, two software zones in alarm, or one smoke detector and one thermal detector.
l. Walk test, with a check for two detectors set to same address.
m. Control-by-time for non-fire operations, with holiday schedules.
n. Day/night automatic adjustment of detector sensitivity.
o. Device blink control for sleeping areas.

10. The FACP shall be capable of coding main panel node notification circuits in March Time (120 PPM), Temporal (NFPA 72 A-2-2.2.2), and California Code. Panel notification circuits (NAC 1,2,3 and 4) shall also support Two-Stage operation, Canadian Dual Stage (3 minutes) and Canadian Dual Stage (5 minutes). Two stage operation shall allow 20 Pulses Per Minute (PPM) on alarm and 120 PPM after 5 minutes or when a second device activates. Canadian Dual stage is the same as Two-Stage except will only switch to second stage by activation of Drill Switch 3- or 5-minute timer. The panel shall also provide a coding option that will synchronize specific strobe lights designed to accept a specific "sync pulse."
11. Network Communication

a. The FACP shall be capable of communicating on a Local Area Network (LAN), a firmware package that utilizes a peer-to-peer, inherently regenerative communication format and protocol.

D. Central Microprocessor

1. The microprocessor shall be a state-of-the-art, high speed, 16-bit RISC device and it shall communicate with, monitor and control all external interfaces. It shall include an EPROM for system program storage, Flash memory for building-specific program storage, and a "watch dog" timer circuit to detect and report microprocessor failure.
2. The microprocessor shall contain and execute all control-by-event programs for specific action to be taken if an alarm condition is detected by the system. Control-by-event equations shall be held in non-volatile programmable memory and shall not be lost even if system primary and secondary power failure occurs.
3. The microprocessor shall also provide a real-time clock for time annotation of system displays, printer, and history file. The time-of-day and date shall not be lost if system primary and secondary power supplies fail. The real time clock may also be used to control non-fire functions at programmed time-of-day, day-of-week, and day-of-year.
4. A special program check function shall be provided to detect common operator errors.
5. An auto-program (self-learn) function shall be provided to quickly install initial functions and make the system operational.
6. For flexibility and to ensure program validity, an optional Windows (TM) based program utility shall be available. This program shall be used to off-line program the system with batch upload/download and have the ability to upgrade the manufacturers (FLASH) system code changes. This program shall also have a verification utility, which scans the program files, identifying possible errors. It shall also have the ability to compare old program files to new ones, identifying differences in the two files to allow complete testing of any system operating changes. This shall be in incompliance with the NFPA 72 requirements for testing after system modification.

E. System Display

1. The system shall support the following display mode options:

    a. The CPU with no display option shall allow the fire alarm control panel to function as a data-gathering panel when the panel is connected to a network with a Network Control Station (NCS) or Network Control Annunciator (NCA). In this application, the NCS or NCA shall provide all of the necessary controls and indicators to be used by the system operator. Programming of

the CPU may be accomplished from the NCS or by use of a laptop PC with the software programming utility connected directly to the CPU.

b. 80-character display option. The display shall include an 80-character backlit alphanumeric Liquid Crystal Display (LCD) and a full PC style QWERTY keypad.

c. 640-character display option. The design of the CPU shall provide for a configuration with the 640 Character display mounted on the front of the CPU in place of the standard 80-character display.

2. The display shall provide all the controls and indicators used by the system operator:

a. The 80-character display shall include the following operator control switches: ACKNOWLEDGE, ALARM SILENCE, ALARM ACTIVATE (drill), SYSTEM RESET, and LAMP TEST.

b. The 640-character display shall include the following operator control switches: ACKNOWLEDGE, ALARM SILENCE, ALARM ACTIVATE (drill), SYSTEM RESET, and LAMP TEST.

3. The display shall annunciate status information and custom alphanumeric labels for all intelligent detectors, addressable modules, internal panel circuits, and software zones.

4. The display shall also provide Light-Emitting Diodes.

a. The 80-character display shall provide 12 Light-Emitting-Diodes (LEDs), that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PREALARM WARNING, SECURITY ALARM, SUPERVISORY SIGNAL, SYSTEM TROUBLE, DISABLED POINTS, ALARM SILENCED, Controls Active, Pre-Discharge, Discharge and Abort.

5. The 640-character display shall provide 11 Light-Emitting-Diodes (LEDs), that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PREALARM WARNING, SECURITY ALARM, SUPERVISORY EVENT, SYSTEM TROUBLE, ALARM SILENCED, DISABLED POINTS, OTHER EVENTS, CPU FAILURE and Controls Active.

6. The display shall have QWERTY type keypad.

a. The 80-character display keypad shall be an easy to use QWERTY type keypad, similar to a PC keyboard. This shall be part of the standard system and have the capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different

password levels shall be provided to prevent unauthorized system control or programming.

b. The 640-character display shall use 10 "soft" keys for screen navigation or to accomplish dedicated programming functions. Full programming access shall require use of a laptop and the proper programming utility.

7. The system shall support the display of battery charging current and voltage on the 80-character LCD display.

F. Signaling Line Circuits (SLC)

1. Each FACP or FACP network node shall support up to two SLCs. Each SLC interface shall provide power to and communicate with up to 159 intelligent detectors (ionization, photoelectric or thermal) and 159 intelligent modules (monitor or control) for a loop capacity of 318 devices. The addition of the optional second loop shall double the device capacity, supporting a total of 636 devices. Each SLC shall be capable of NFPA 72 Style 4, Style 6, or Style 7 (Class A or B) wiring.
2. CPU shall receive analog information from all intelligent detectors to be processed to determine whether normal, alarm, prealarm, or trouble conditions exist for each detector. The software shall automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information shall also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.

G. Serial Interfaces

1. The system shall include two serial EIA-232 interfaces. Each interface shall be a means of connecting UL Listed Information Technology Equipment (ITE) peripherals.

   a. One EIA-232 interface shall be used to connect an UL-Listed 40 or 80 column printer. Printers that are not UL-Listed are not considered acceptable substitutes.
   b. One EIA-232 interface shall be used to connect an UL-Listed 40 or 80 column printer. Printers that are not UL-Listed are not considered acceptable substitutes.
   c. One EIA-232 interface shall be used to connect a UL-listed CRT terminal. This interface shall include special protocol methods that allow off-site monitoring of the FACP over standard dial-up phone lines. This ancillary

capability shall allow remote readout of all status information, including analog values, and shall not interfere with or degrade FACP operations when used. It shall allow remote FACP Acknowledge, Reset, or Signal Silence in this mode. It shall also allow adjustment of detector sensitivity and readout of the history file.

d. The system shall include an EIA-485 port for the serial connection of optional annunciators and remote LCD displays.
e. The EIA-485 interface may be used for network connection to a proprietary-receiving unit.

H. Voice Command Center (VCC)

1. The facility shall have an emergency voice alarm communication system. Digitally stored message sequences shall notify the building occupants that a fire or life safety condition has been reported. A Message generator shall be capable of automatically distributing up to four (4) simultaneous, unique messages to appropriate audio zones within the facility based on the type and location of the initiating event. The Fire Command Center (FCC) shall also support Emergency manual voice announcement capability for both system wide or selected audio zones and shall include provisions for the system operator to override automatic messages system wide or in selected zones.
   a. The digital audio message generator shall be of reliable, non-moving parts, and support the digital storage of at least 16 or 32 minutes of tones and emergency messages, shall support programming options to string audio segments together to create up to 1000 messages, or to loop messages and parts of messages to repeat for pre-determined cycles or indefinitely.
   b. The audio portion of the system shall sound the proper audio signal (consisting of tone, voice, or tone and voice) to the appropriate zones.
   c. Notification Appliance Circuits (NAC) speaker circuits shall be arranged such that there is a minimum of one speaker circuit per floor of the building or smoke zone whichever is greater.
   d. Audio amplifiers and tone generating equipment shall be electrically supervised for normal and abnormal conditions.
   e. Speaker circuits shall be electrically supervised for open and short circuit conditions. If a short circuit exists on a speaker circuit, it shall not be possible to activate that circuit.
   f. Speaker circuits shall be either 25 VRMS or 70VRMS. Speaker circuits shall have 20% space capacity for future expansion or increased power output requirements.

2. The emergency voice alarm communication system shall incorporate a Two-way emergency telephone communication system.
   a. Two-way emergency telephone communication circuits shall be supervised for open and short circuit conditions.

b. Two-way emergency telephone (Fire Fighter Telephone) communication shall be supported between the Audio Command Center and up to seven (7) remote Fire Fighter's Telephone locations simultaneously on a telephone riser.
c. Means shall be provided to connect FFT voice communications to the speaker circuits to allow voice paging over the speaker circuit from a telephone handset.

I. Enclosures:

1. The control panel shall be housed in a UL-listed cabinet suitable for surface or semi-flush mounting. The cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.
2. The back box and door shall be constructed of 0.060 steel with provisions for electrical conduit connections into the sides and top.
3. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators. For convenience, the door may be site configured for either right or left hand hinging.

J. Power Supply:

1. A high tech off-line switching power supply shall be available for the fire alarm control panel or network node and provide 6.0 amps of available power for the control panel and peripheral devices.
2. Provisions will be made to allow the audio-visual power to be increased as required by adding modular expansion audio-visual power supplies.
3. Positive-Temperature-Coefficient (PTC) thermistors, circuit breakers, or other over-current protection shall be provided on all power outputs. The power supply shall provide an integral battery charger for use with batteries up to 55 AH or may be used with an external battery and charger system. Battery arrangement may be configured in the field.
4. The power supply shall continuously monitor all field wires for earth ground conditions, and shall have the following LED indicators:

Ground Fault LED

AC Power Fail LED

NAC on LED (4)

5. The main power supply shall operate on 120 VAC, 60 Hz, and shall provide all necessary power for the FACP.
6. The main power supply shall provide a battery charger using dual-rate charging techniques for fast battery recharge and be capable of charging batteries up to 200 AH.
7. All circuits shall be power-limited, per UL864 requirements.

K. Auxiliary Field Power Supply - Addressable

1. The auxiliary addressable power supply is a remote 24 VDC power supply used to power Notification Devices and field devices that require regulated 24VDC power. The power supply shall also include and charge backup batteries.
2. The addressable power supply for the fire alarm system shall provide up a minimum of 6.0 amps of 24 volt DC regulated power for Notification Appliance Circuit (NAC) power or 5 amps of 24 volt DC general power. The power supply shall have an additional .5 amp of 24 VDC auxiliary power for use within the same cabinet as the power supply. It shall include an integral charger designed to charge 7.0 - 25.0 amp hour batteries.
3. The addressable power supply shall provide four individually addressable Notification Appliance Circuits that may be configured as two Class "A" and two Class "B" or four Class "B" only circuits. All circuits shall be power-limited per UL 864 requirements.
4. The addressable power supply shall provide built-in synchronization for certain Notification Appliances on each circuit without the need for additional synchronization modules. The power supply's output circuits shall be individually selected for synchronization. A single addressable power supply shall be capable of supporting both synchronized and non-synchronized Notification Devices at the same time.
5. The addressable power supply shall operate on 120 or 240 VAC, 50/60 Hz.
6. The interface to the power supply from the Fire Alarm Control Panel (FACP) shall be via the Signaling Line Circuit (SLC) or other multiplexed means Power supplies that do not use an intelligent interface are not suitable substitutes. The required wiring from the FACP to the addressable power supply shall be a single unshielded twisted pair wire. Data on the SLC shall be transmitted between 24 VDC, 5 VDC and 0 VDC at approximately 3.33k baud.
7. The addressable power supply shall supervise for battery charging failure, AC power loss, power brownout, battery failure, NAC loss, and optional ground fault detection. In the event of a trouble condition, the addressable power supply shall report the incident and the applicable address to the FACP via the SLC.
8. The addressable power supply shall have an AC Power Loss Delay option. If this option is utilized and the addressable power supply experiences an AC power loss, reporting of the incident to the FACP will be delayed. A delay time of eight or sixteen hours shall be Dip-switch selected.

9. The addressable power supply shall have an option for Canadian Trouble Reporting and this option shall be Dip-switch selectable.
10. The addressable power supply mounts in either the FACP backbox or it's own dedicated surface mounted backbox with cover.
11. Each of the power supply's four output circuits shall be DIP-switch selected for Notification Appliance Circuit or General Purpose 24 VDC power. Any output circuit shall be able to provide up to 2.5 amps of 24 VDC power.
12. The addressable power supply's output circuits shall be individually supervised when they are selected to be either a Notification Appliance Circuit when wired Class "A" or by the use of and end-of-line resistor. When the power supply's output circuit is selected as General 24VDC power, the circuit shall be individually supervised when an end-of-line relay is used.
13. When selected for Notification Appliance Circuits, the output circuits shall be individually DIP-switch selectable for Steady, March Time, Dual Stage or Temporal.
14. When selected as a Notification Appliance Circuit, the output circuits of the addressable power supply shall have the option to be coded by the use of a universal zone coder.
15. The addressable power supply shall interface and synchronize with other power supplies of the same type. The required wiring to interface multiple addressable power supplies shall be a single unshielded, twisted pair wire.
16. An individual or multiple interfaced addressable power supplies shall have the option to use an external charger for battery charging. Interfaced power supplies shall have the option to share backup battery power.

L. Field Charging Power Supply (FCPS)

The FCPS is a device designed for use as either a remote 24 volt power supply or used to power Notification Appliances.

1. The FCPS shall offer up to 6.0 amps (4.0 amps continuous) of regulated 24 volt power. It shall include an integral charger designed to charge 7.0 amp hour batteries and to support 60 hour standby.
2. The Field Charging Power Supply shall have two input triggers. The input trigger shall be a Notification Appliance Circuit (from the fire alarm control panel) or a relay. Four outputs (two Style Y or Z and two style Y) shall be available for connection to the Notification devices.
3. The FCPS shall include an attractive surface mount backbox.
4. The Field Charging Power Supply shall include the ability to delay the AC fail delay per NFPA requirements.
5. The FCPS include power limited circuitry, per 1995 UL standards.

M. Specific System Operations

1. Smoke Detector Sensitivity Adjust: A means shall be provided for adjusting the sensitivity of any or all addressable intelligent detectors in the system from the system keypad. Sensitivity range shall be within the allowed UL window and have a minimum of 9 levels.
2. Alarm Verification: Each of the intelligent addressable smoke detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification delay shall be programmable from 5 to 30 seconds and each detector shall be able to be selected for verification. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.
3. Point Disable: Any addressable device or conventional circuit in the system may be enabled or disabled through the system keypad.
4. Point Read: The system shall be able to display or print the following point status diagnostic functions:

    a. Device status
    b. Device type
    c. Custom device label
    d. View analog detector values
    e. Device zone assignments
    f. All program parameters

5. System Status Reports: Upon command from an operator of the system, a status report will be generated and printed, listing all system status.
6. System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 800 events. Up to 200 events shall be dedicated to alarm and the remaining events are general purpose. Systems that do not have dedicated alarm storage, where events are overridden by non-alarm type events, are not suitable substitutes. Each of these activations will be stored and time and date stamped with the actual time of the activation. The contents of the history buffer may be manually reviewed, one event at a time, or printed in its entirety. The history buffer shall use non-volatile memory. Systems that use volatile memory for history storage are not acceptable substitutes.
7. Automatic Detector Maintenance Alert: The fire alarm control panel shall automatically interrogate each intelligent detector and shall analyze the detector responses over a period of time. If any intelligent detector in the system responds with a reading that is above or below normal limits, then the system will enter the trouble mode, and the particular detector will be annunciated on the system display, and printed on the optional printer. This feature shall in no way inhibit the

receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.

8. Pre-Alarm Function: The system shall provide two levels of pre-alarm warning to give advance notice of a possible fire situation. Both pre-alarm levels shall be fully field adjustable. The first level shall give an audible indication at the panel. The second level shall give an audible indication and may also activate control relays. The system shall also have the ability to activate local detector sounder bases at the pre-alarm level, to assist in avoiding nuisance alarms.
9. Software Zones: The FACP shall provide 100 software zones, 10 additional special function zones, 10 releasing zones, and 20 logic zones.
10. The fire alarm control panel shall include a walk test feature. It shall include the ability to test initiating device circuits and notification appliance circuits from the field without returning to the panel to reset the system. Operation shall be as follows:

    a. Alarming an initiating device shall activate programmed outputs, which are selected to participate in walk test, for 3 seconds.
    b. Introducing a trouble into the initiating device shall activate the programmed outputs for 8 seconds.
    c. All devices tested in walk test shall be recorded in the history buffer.

11. Waterflow Operation
    An alarm from a waterflow detection device shall activate the appropriate alarm message on the main panel display, turn on all programmed notification appliance circuits and shall not be affected by the signal silence switch.
12. Supervisory Operation
    An alarm from a supervisory device shall cause the appropriate indication on the system display, light a common supervisory LED, but will not cause the system to enter the trouble mode.
13. Signal Silence Operation
    The FACP shall have the ability to program each output circuit (notification, relay, speaker etc) to deactivate upon depression of the signal silence switch.
14. Non-Alarm Input Operation
    Any addressable initiating device in the system may be used as a non-alarm input to monitor normally open contact type devices. Non-alarm functions are a lower priority than fire alarm initiating devices.
15. Combo Zone
    A special type code shall be available to allow waterflow and supervisory devices to share a common addressable module. Waterflow devices shall be wired in parallel, supervisory devices in series.

2.04 SYSTEM COMPONENTS

A. Programmable Electronic Sounders:

1. Electronic sounders shall operate on 24 VDC nominal.
2. Electronic sounders shall be field programmable without the use of special tools, at a sound level of at least 90 dBA measured at 10 feet from the device.
3. Shall be flush or surface mounted as shown on plans.

B. Speakers:

1. All speakers shall operate on 25 VRMS or with field selectable output taps from 0.5 to 2.0 Watts.
2. Speakers in corridors and public spaces shall produce a nominal sound output of 84 dBA at 10 feet (3m).
3. Frequency response shall be a minimum of 400 HZ to 4000 HZ.
4. The back of each speaker shall be sealed to protect the speaker cone from damage and dust.

C. Strobe lights shall meet the requirements of the ADA, UL Standard 1971, be fully synchronized, and shall meet the following criteria:

1. The maximum pulse duration shall be 2/10 of one second.
2. Strobe intensity shall meet the requirements of UL 1971.
3. The flash rate shall meet the requirements of UL 1971.

D. Manual Fire Alarm Stations

1. Manual fire alarm stations shall be non-code, non-breakglass type, equipped with key lock so that they may be tested without operating the handle.
2. Stations must be designed such that after an actual activation, they cannot be restored to normal except by key reset.
3. An operated station shall automatically condition itself so as to be visually detected, as operated, at a minimum distance of 100 feet (30.5 m) front or side.
4. Manual stations shall be constructed of high impact Lexan, with operating instructions provided on the cover. The word FIRE shall appear on the manual station in letters one half inch (12.7 mm) in size or larger.

E. Conventional Photoelectric Area Smoke Detectors

1. Photoelectric smoke detectors shall be a 24 VDC, two wire, ceiling-mounted, light scattering type using an LED light source.
2. Each detector shall contain a remote LED output and a built-in test switch.
3. Detector shall be provided on a twist-lock base.
4. It shall be possible to perform a calibrated sensitivity and performance test on the detector without the need for the generation of smoke. The test method shall test all detector circuits.
5. A visual indication of an alarm shall be provided by dual latching Light Emitting Diodes (LEDs), on the detector, which may be seen from ground level over 360 degrees. These LEDs shall flash at least every 10 seconds, indicating that power is applied to the detector.
6. The detector shall not go into alarm when exposed to air velocities of up to 3000 feet (914.4 m) per minute.
7. The detector screen and cover assembly shall be easily removable for field cleaning of the detector chamber.
8. All field wire connections shall be made to the base through the use of a clamping plate and screw.

F. Conventional Ionization Type Area Smoke Detectors

1. Ionization type smoke detectors shall be a two wire, 24 VDC type using a dual unipolar chamber.
2. Each detector shall contain a remote LED output and a built-in test switch.
3. Detector shall be provided on a twist-lock base.
4. It shall be possible to perform a calibration sensitivity and performance test on the detector without the need for the generation of smoke.
5. A visual indication of an alarm shall be provided by dual latching Light Emitting Diodes (LEDs) over 360 degrees, on the detector, which may be seen from ground level. This LED shall flash every 10 seconds, indicating that power is applied to the detector.
6. The detector shall not alarm when exposed to air velocities of up to 1,200 feet (365.76 m) per minute. The detector screen and cover assembly shall be easily removable for field cleaning of the detector chamber.
7. All field wire connections shall be made to the base through the use of a clamping plate and screw.

G. Duct Smoke Detectors

Duct smoke detectors shall be a 24 VDC type with visual alarm and power indicators, and a reset switch. Each detector shall be installed upon the composite supply/return air ducts(s), with properly sized air sampling tubes.

H. Projected Beam Detectors

1. The projected beam type shall be a 4-wire 24 VDC device.
2. The detector shall be listed to UL 268 and shall consist of a separate transmitter and receiver capable of being powered separately or together.
3. The detector shall operate in either a short range (30' - 100') or long range (100' - 330') mode.
4. The temperature range of the device shall be -22 degrees F to 131 degrees F.
5. The detector shall feature a bank of four alignment LEDs on both the receiver and the transmitter that are used to ensure proper alignment of unit without special tools.
6. Beam detectors shall feature automatic gain control which will compensate for gradual signal deterioration from dirt accumulation on lenses.
7. The unit shall be both ceiling and wall mountable.
8. The detector shall have the ability to be tested using calibrated test filters or magnet activated remote test station.

I. Automatic Conventional Heat Detectors

1. Automatic heat detectors shall have a combination rate of rise and fixed temperature rated at 135 degrees Fahrenheit (57.2 Celsius) for areas where ambient temperatures do not exceed 100 degrees (37.7 Celsius), and 200 degrees (93.33 Celsius) for areas where the temperature does not exceed 150 degrees (65.5 Celsius).
2. Automatic heat detectors shall be a low profile, ceiling mount type with positive indication of activation.
3. The rate of rise element shall consist of an air chamber, a flexible metal diaphragm, and a factory calibrated, moisture-proof, trouble free vent, and shall operate when the rate of temperature rise exceeds 15 degrees F (9.4 degrees C) per minute.
4. The fixed temperature element shall consist of a fusible alloy retainer and actuator shaft.
5. Automatic heat detectors shall have a smooth ceiling rating of 2500 square feet (762 square meters).

J. Waterflow Indicator:

1. Waterflow Switches shall be an integral, mechanical, non-coded, non-accumulative retard type.
2. Waterflow Switches shall have an alarm transmission delay time which is conveniently adjustable from 0 to 60 seconds. Initial settings shall be 30-45 seconds.
3. All waterflow switches shall come from a single manufacturer and series.
4. Waterflow switches shall be provided and connected under this section but installed by the mechanical contractor.
5. Where possible, locate waterflow switches a minimum of one (1) foot from a fitting which changes the direction of the flow and a minimum of three (3) feet from a valve.

K. Sprinkler and Standpipe Valve Supervisory Switches:

1. Each sprinkler system water supply control valve riser, zone control valve, and standpipe system riser control valve shall be equipped with a supervisory switch. Standpipe hose valves, and test and drain valves shall not be equipped with supervisory switches.
2. PIV (post indicator valve) or main gate valves shall be equipped with a supervisory switch.
3. The switch shall be mounted so as not to interfere with the normal operation of the valve and adjusted to operate within two revolutions toward the closed position of the valve control, or when the stem has moved no more than one-fifth of the distance from its normal position.
4. The supervisory switch shall be contained in a weatherproof aluminum housing, which shall provide a 3/4-inch (19 mm) conduit entrance and incorporate the necessary facilities for attachment to the valves.
5. The switch housing shall be finished in red baked enamel.
6. The entire installed assembly shall be tamper proof and arranged to cause a switch operation if the housing cover is removed, or if the unit is removed from its mounting.
7. Valve supervisory switches shall be provided and connected under this section and installed by mechanical contractor.

    a. This unit shall provide for each zone: alarm indications, using a red alarm a yellow trouble long-life LEDs and control switches for the control of fire alarm control panel functions. The annunciator will also have an ON-LINE LED, local piezo electric signal, local acknowledge/lamp test switch, and custom slide-in zone/function identification labels.
    b. Switches shall be available for remote annunciation and control of output points in the system, system acknowledge, telephone zone select, speaker select, global signal silence, and global system reset within the confines of all applicable standards.

L. Alphanumeric LCD Type Annunciator:

1. The alphanumeric display annunciator shall be a supervised, remotely located back-lit LCD display containing a minimum of eighty (80) characters for alarm annunciation in clear English text.
2. The LCD annunciator shall display all alarm and trouble conditions in the system.
3. An audible indication of alarm shall be integral to the alphanumeric display.
4. The display shall be UL listed for fire alarm application.
5. It shall be possible to connect up to 32 LCD displays and be capable of wiring distances up to 6,000 feet from the control panel.
6. The annunciator shall connect to a separate, dedicated "terminal mode" EIA-485 interface. This is a two-wire loop connection and shall be capable of distances to 6,000 feet. Each terminal mode LCD display shall mimic the main control panel.
7. The system shall allow a minimum of 32 terminal mode LCD annunciators. Up to 10 LCD annunciators shall be capable of the following system functions: Acknowledge, Signal Silence and Reset, which shall be protected from unauthorized use by a keyswitch or password.
8. The LED annunciator shall offer an interface to a graphic style annunciator and provide each of the features listed above.

M. Portable Emergency Telephone Handset Jack

1. Portable emergency telephone handset jacks shall be flush mounted on stainless steel plates as indicated on the plans. Jacks shall be approved for emergency telephone system application.
2. Insertion of a portable handset plug into a jack shall send a signal to the fire command center, which shall audibly and visually indicate the on-line condition, and shall sound a "ring" indication in the handset.
3. The two-way emergency telephone system shall support a minimum of seven (7) handsets on line without degradation of the signal.

N. Fixed Emergency Telephone Handset

1. The telephone cabinet shall be painted red and clearly labeled as "Emergency Telephone." The cabinets shall be located where shown on drawings.
2. The handset cradle shall have a switch connection so that lifting the handset off of the cradle shall send a signal to the fire command center, which shall audibly and visually indicate its on-line (off-hook) condition.
3. On activating the remote phone, the phone earpiece shall sound a telephone ring signal until the master handset is lifted.

4. The two-way emergency telephone system shall support a minimum of seven (7) handsets on line without degradation of the signal.

O. All interfaces and associated equipment are to be protected so that they will not be affected by voltage surges or line transients consistent with UL standard 864.

P. Field Wiring Terminal Blocks

For ease of service all panel I/O wiring terminal blocks shall be removable, plug-in types and have sufficient capacity for #18 to #12 AWG wire. Terminal blocks that are permanently fixed are not acceptable.

Q. Printer

1. The printer shall provide hard-copy printout of all changes in status of the system and shall time-stamp such printouts with the current time-of-day and date. The printer shall be standard carriage with 80-characters per line and shall use standard pin-feed paper. The printer shall be enclosed in a separate cabinet suitable for placement on a desktop or table. The printer shall communicate with the control panel using an interface complying with Electrical Industries Association standard EIA-232D. Power to the printer shall be 120 VAC @ 60 Hz.
2. The system shall have a strip printer capable of being mounted directly in the main FACP enclosure. Alarms shall be printed in easy-to-read RED, other messages, such as a trouble, shall be printed in BLACK. This printer shall receive power from the system power supply and shall operate via battery back-up if AC mains are lost. The strip printer shall be UL 864 listed.
3. The system shall have a strip printer capable of being mounted directly in the main FACP enclosure. Alarms shall be printed in easy-to-read RED, other messages, such as a trouble, shall be printed in BLACK. This printer shall receive power from the system power supply and shall operate via battery back-up if AC mains are lost. The strip printer shall be UL 864 listed.

R. Video Display Terminal

1. The Video Display Terminal shall provide a visual display and an audible alert of all changes in status of the system and shall annotate such displays with the current time-of-day and date.
2. The Video Display Terminal shall be enclosed in a cabinet suitable for placement on a desktop or table.

3. A detachable keyboard shall be provided that may be used for programming, testing, and control of the system. Individual keys shall be provided on the keyboard for the ACKNOWLEDGE, RESET, LAMP TEST, SYSTEM TEST, and SIGNAL SILENCE functions of the control panel.
4. The video display terminal shall include a count of all alarms and troubles in the system, as well as a count of all alarms and trouble requiring acknowledgment. These counts shall be continuously displayed during all FACP operations.

2.05 SYSTEM COMPONENTS – ADDRESSABLE DEVICES

A. Addressable Devices - General

1. Addressable devices shall use simple to install and maintain decade, decimal address switches. Devices shall be capable of being set to an address in a range of 001 to 159.
2. Addressable devices, which use a binary-coded address setting method, such as a DIP-switch, are not an allowable substitute.
3. Detectors shall be intelligent (analog) and addressable and shall connect with two wires to the fire alarm control panel Signaling Line Circuits.
4. Addressable smoke and thermal detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash green under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady red illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.
5. The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. The panel on a time-of-day basis shall automatically adjust sensitivity.
6. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.
7. The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Bases shall include a sounder base with a built-in (local) sounder rated at 85 DBA minimum, a relay base and an isolator base designed for Style 7 applications.
8. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.
9. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).

10. Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.
11. Addressable devices shall store an internal identifying code that the control panel shall use to identify the type of device.
12. A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.
13. Addressable modules shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box. An optional surface mount Lexan enclosure shall be available.

B. Addressable Manual Fire Alarm Box (manual station)

1. Addressable manual fire alarm boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
3. Manual fire alarm boxes shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches (44 mm) or larger.

C. Intelligent Photoelectric Smoke Detector

1. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.

D. Intelligent Laser Photo Smoke Detector

1. The intelligent laser photo smoke detector shall be a spot type detector that incorporates an extremely bright laser diode and an integral lens that focuses the light beam to a very small volume near a receiving photo sensor. The scattering of smoke particles shall activate the photo sensor.

2. The laser detector shall have conductive plastic so that dust accumulation is reduced significantly.
3. The intelligent laser photo detector shall have nine sensitivity levels and be sensitive to a minimum obscuration of 0.03 percent per foot.
4. The laser detector shall not require expensive conduit, special fittings or PVC pipe.
5. The intelligent laser photo detector shall support standard, relay, isolator and sounder detector bases.
6. The laser photo detector shall not require other cleaning requirements than those listed in NFPA 72. Replacement, refurbishment or specialized cleaning of the detector head shall not be required.
7. The laser photo detector shall include two bicolor LEDs that flash green in normal operation and turn on steady red in alarm.

E. Intelligent Ionization Smoke Detector

1. The detectors shall use the dual-chamber ionization principal to measure products of combustion and shall, on command from the control panel, send data to the panel representing the analog level of products of combustion.

F. Intelligent Multi Criteria Acclimating Detector

1. The intelligent multi criteria Acclimate detector shall be an addressable device that is designed to monitor a minimum of photoelectric and thermal technologies in a single sensing device. The design shall include the ability to adapt to its environment by utilizing a built-in microprocessor to determine it's environment and choose the appropriate sensing settings. The detector design shall allow a wide sensitivity window, no less than 1 to 4% per foot obscuration. This detector shall utilize advanced electronics that react to slow smoldering fires and thermal properties all within a single sensing device.
2. The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing, kitchen etc.) and then have the ability to automatically change the setting as the environment changes (as walls are moved or as the occupancy changes).
3. The intelligent multi criteria detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena.

G. Intelligent Thermal Detectors

1. Thermal detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit.

H. Intelligent Duct Smoke Detector

1. The smoke detector housing shall accommodate either an intelligent ionization detector or an intelligent photoelectric detector, of that provides continuous analog monitoring and alarm verification from the panel.
2. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.

I. Hostile-Area Smoke Detector

1. The detector shall be designed to provide early warning smoke detection in environments where traditional smoke detectors are not practical.
2. The detector shall have a filter system to remove particles down to 25 microns.
3. This filter system shall remove unwanted airborne particles and water mist. This shall allow the detector to operate in environments where traditional smoke detectors would have nuisance alarms.
4. The filter system shall consist of 2 filters one of which is field replaceable.
5. The filter system shall have an intake fan to draw air and smoke through the filters into the sensing chamber.
6. The filter system shall be supervised so that if the filter is clogged or the fan fails the control panel reports trouble.
7. The filter system shall be powered from 24 VDC separate from the SLC communications.
8. The detector shall utilize a photoelectric sensing chamber.

J. Addressable Dry Contact Monitor Module

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLCs.
2. The IDC zone shall be suitable for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
3. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4-inch (70 mm) x 1-1/4 inch (31.7 mm) x 1/2 inch (12.7 mm). This version need not include Style D or an LED.

K. Two Wire Detector Monitor Module

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional 2-wire smoke detectors or alarm initiating devices (any N.O. dry contact device).
2. The IDC zone may be wired for Class A or B (Style D or Style B) operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

L. Addressable Control Module

1. Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances.
2. The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation.
3. Audio/visual power shall be provided by a separate supervised power circuit from the main fire alarm control panel or from a supervised UL listed remote power supply.
4. The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC.

M. Addressable Relay Module

1. Addressable Relay Modules shall be available for HVAC control and other building functions. The relay shall be form C and rated for a minimum of 2.0 Amps resistive or 1.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to ensure that 100% of

all auxiliary relay or NACs may be energized at the same time on the same pair of wires.

N. Isolator Module

1. Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch. At least one isolator module shall be provided for each floor or protected zone of the building.
2. If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.
3. The isolator module shall not require address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.
4. The isolator module shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

O. Smoke Control Annunciator

1. On/Auto/Off switches and status indicators (LEDS) shall be provided for monitoring and manual control of each fan, damper, HVAC control unit, stairwell pressurization fan, and smoke exhaust fan. To ensure compliance the units supplied shall meet the following UL categories: UUKL, PAZX, UDTZ, QVAX as well as the requirements of NFPA 90A, HVAC, and NFPA 92A & 92B, Smoke Control. The control System shall be field programmable for either 90A operation or 92A/B operation to allow for future use and system expansion.
2. The OFF LED shall be Yellow, the ON LED shall be green, the Trouble/Fault LED shall be Amber/Orange for each switch. The Trouble/Fault indicator shall indicate a trouble in the control and/or monitor points associated with that switch. In addition, each group of eight switches shall have two LEDS and one momentary switch which allow the following functions: An Amber LED to indicate an OFF-NORMAL switch position, in the ON or OFF position; A Green LED to indicate ALL AUTO switch position; A Local Acknowledge/Lamp Test momentary switch.
3. Each switch shall have the capability to monitor and control two addressable inputs and two addressable outputs. In all modes, the ON and OFF indicators shall continuously follow the device status not the switch position. Positive feedback shall be employed to verify correct operation of the device being controlled. Systems that indicate on/off/auto by physical switch position only are not acceptable.

4. All HVAC switches (i.e., limit switches, vane switches, etc.) shall be provided and installed by the HVAC contractor.
5. It shall be possible to meet the requirements mentioned above utilizing wall mounted custom graphic.

2.06 BATTERIES

A. The battery shall have sufficient capacity to power the fire alarm system for not less than twenty-four hours plus 15 minutes of alarm upon a normal AC power failure.

B. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks for refilling, spills, and leakage shall not be required.

C. If necessary, to meet standby requirements, external battery and charger systems may be used.

2.07 CABLE

A. Alarm initiating circuit shall wiring and annunciator wiring shall be of type and size recommended by equipment manufacturer. Cable shall be U.L. Listed for use with local protective signaling system.

2.08 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:

1. Manual Stations
2. Heat Detectors
3. Smoke detectors.
4. Duct Smoke Detectors
5. Carbon Monoxide Detectors
6. Automatic Sprinkler System Water Flow
7. Fire-extinguishing system operation
8. Fire standpipe system

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm-notification appliances.
2. Identify alarm and specific initiating device at the fire-alarm control unit and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
7. Close smoke dampers in air ducts of designated air-conditioning duct systems.
8. Activate emergency lighting control.
9. Activate emergency shutoffs for gas and fuel supplies.
10. Record events in the system memory.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch
2. Elevator shunt trip supervision
3. Loss of communication with any panel on the network.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire-alarm control unit.
4. Ground or a single break in fire-alarm control unit internal circuits.
5. Abnormal ac voltage at fire-alarm control unit.
6. Break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at fire-alarm control unit or annunciator.
9. Fire-pump power failure, including a dead-phase or phase-reversal condition.
10. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system.

E. System Supervisory Signal Actions:

1. Initiate notification appliances
2. Identify specific device initiating the event at fire-alarm control unit and remote annunciators.
3. After a time delay of 200 seconds, transmit a trouble or supervisory signal to th remote alarm receiving station.

F. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.

4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
5. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.

G. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

2.09 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.

B. Chimes, Low-Level Output: Vibrating type, 75-dBA minimum rated output.

C. Chimes, High-Level Output: Vibrating type, 81-dBA minimum rated output.

D. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.

E. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.

1. Rated Light Output:
   a. 15/30/75/110 cd, selectable in the field.
2. Mounting: Wall mounted unless otherwise indicated.
3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
4. Flashing shall be in a temporal pattern, synchronized with other units.
5. Strobe Leads: Factory connected to screw terminals.
6. Mounting Faceplate: Factory finished, red.

2.010 ADDRESSABLE INTERFACE DEVICE

A. General:
   1. Include address-setting means on the module.
   2. Store an internal identifying code for control panel use to identify the module type.
   3. Listed for controlling HVAC fan motor controllers.

B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.

C. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall.

   1. Allow the control panel to switch the relay contacts on command.
   2. Have a minimum of two normally open and two normally closed contacts available for field wiring.

D. Control Module:
   1. Operate notification devices.
   2. Operate solenoids for use in sprinkler service.

2.011 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture **one** telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:

   1. Verification that both telephone lines are available.
   2. Programming device.
   3. LED display.
   4. Manual test report function and manual transmission clear indication.
   5. Communications failure with the central station or fire-alarm control unit.

D. Digital data transmission shall include the following:

1. Address of the alarm-initiating device.
2. Address of the supervisory signal.
3. Address of the trouble-initiating device.
4. Loss of ac supply.
5. Loss of power.
6. Low battery.
7. Abnormal test signal.
8. Communication bus failure.

E. Secondary Power: Integral rechargeable battery and automatic charger.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.012 DEVICE GUARDS

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
1. Factory fabricated and furnished by device manufacturer.
2. Finish: Paint of color to match the protected device.Prin

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 EQUIPMENT INSTALLATION

A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

1. Devices placed in service before all other trades have completed cleanup shall be replaced.
2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

B. Install wall-mounted equipment, with tops of cabinets not more than 78 inches (1980 mm) above the finished floor.

C. Manual Fire-Alarm Boxes:

1. Install manual fire-alarm box in the normal path of egress within 60 inches (1520 mm) of the exit doorway.
2. Mount manual fire-alarm box on a background of a contrasting color.
3. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.

D. Smoke- or Heat-Detector Spacing:

1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
3. Smooth ceiling spacing shall not exceed **30 feet**.
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A in NFPA 72.
5. HVAC: Locate detectors not closer than **36 inches** from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.

E. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

F. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches long shall be supported at both ends.

1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

G. Air-Sampling Smoke Detectors: If using multiple pipe runs, the runs shall be pneumatically balanced.

H. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.

I. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

J. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

K. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling. Install all devices at the same height unless otherwise indicated.

L. Device Location-Indicating Lights: Locate in public space near the device they monitor.

M. Antenna for Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that resists 100-mph wind load with a gust factor of 1.3 without damage.

3.03 PATHWAYS

A. Pathways above recessed ceilings and in nonaccessible locations may be routed exposed.

1. Exposed pathways located less than 96 inches above the floor shall be installed in EMT.

B. Pathways shall be installed in EMT.

C. Exposed EMT shall be painted red enamel.

3.04 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches from the device

controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Alarm-initiating connection to smoke-control system (smoke management) at firefighters' smoke-control system panel.
2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
3. Smoke dampers in air ducts of designated HVAC duct systems.
4. Magnetically held-open doors.
5. Electronically locked doors and access gates.
6. Alarm-initiating connection to elevator recall system and components.
7. Alarm-initiating connection to activate emergency lighting control.
8. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
9. Supervisory connections at valve supervisory switches.
10. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
11. Supervisory connections at elevator shunt-trip breaker.
12. Data communication circuits for connection to building management system.
13. Data communication circuits for connection to mass notification system.
14. Supervisory connections at fire-extinguisher locations.
15. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
16. Supervisory connections at fire-pump engine control panel.

3.05 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install framed instructions in a location visible from fire-alarm control unit.

3.06 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.07 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by Engineer and/or authorities having jurisdiction.

B. Perform tests and inspections.

C. Perform the following tests and inspections:

1. Visual Inspection: Conduct visual inspection prior to testing.

    a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
    b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

E. Fire-alarm system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

H. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.08 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 283111

SECTION 2100 - GRADING AND SITE REPARATION
CITY OF LEE'S SUMMIT, MISSOURI
STANDARD SPECIFICATIONS

TABLE OF CONTENTS

SECTION 2101 CLEARING, GRUBBING, AND SITE PREPARATION

2101.1 Scope

This section governs the furnishing of all labor, materials, and equipment for the performance of all clearing, grubbing, and demolition within the limits of work as shown on the Plans and in accordance with the Standard Drawings, the Specifications, and the Special Provisions.

2101.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

APWA
2150 Erosion and Sediment Control
2201 Subgrade Preparation
2203 Aggregate Base
2307 Fencing
2700 Structures

ASTM
ASTM C 150 Standard Specification for Portland Cement
ASTM C 260 Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C 33 Standard Specification for Concrete Aggregates
ASTM C 494 Standard Specification for Chemical Admixtures for Concrete
ASTM C 618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM D 698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM C 1602 Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D 4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 4832 Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders

Kansas Department of Transportation
Standard Specifications for State Road and Bridge Construction,
Current Edition KDOT AB-3 Aggregate Base

Missouri Highways and Transportation Commission
Missouri Standard Specifications for Highway Construction,
Current Edition MoDOT Types 1 or 5 Aggregate Base

2101.3 Definitions

The following terms have the meanings indicated:

A. Clearing: Clearing shall consist of removing all vegetative matter such as trees, brush, down timber and other objectionable materials found on or above the surface of the site. It shall include removing buildings, fences, lumber, waste dumps and trash and the salvaging of such materials as may be specified and disposing of the debris.

The Contractor shall not occupy any portion of the Project Site prior to the date established in the Notice to Proceed without prior approval of the Owner.

B. Grubbing: Grubbing shall consist of removing and disposing of all vegetative matter such as stumps, roots, buried trees and brush encountered below the surface of the ground or subgrade, whichever is lower, which have not been included in Section 2101.2.A entitled "Clearing".

Trees to be removed shall be completely removed, including stump and large roots, unless such removal may result in damage to existing utilities. In that event, trees shall be sawn off not more than four (4) inches above the ground and the stump shall be removed to twelve (12) inches below finish grade.

In all cases of grubbing, the vegetative matter shall be removed to a minimum depth of 12 inches below ground line or subgrade, whichever is lower, except as provided in Section 2101.3.C.

When deleterious materials are encountered below ground line which may be detrimental to the proposed improvement, these materials shall be removed to a depth necessary to provide adequate support for the proposed improvement.

C. Site Preparation: Site Preparation shall consist of all initial preparation work for the project site and includes, but is not limited to: steps to minimize site disturbance of existing vegetative, structures and private property; phasing and sequence construction activities into logical work zones; installation of erosion control measures; topsoil stripping, stockpiling and spreading; identifying haul roads, construction entrances and/or exits, construction parking areas; mailbox and fencing adjustments; etc. All site preparation shall be considered incidental unless such site preparation is listed separately in the Contract Documents.

D. Demolition and Removal: This work shall consist of demolishing, removing, and disposing of all structures and improvements within the construction limits unless included in other items of work as shown on the Plans or in the Special Provisions. This work shall apply to all structures and improvements, whether on, above or below the surface of the ground or subgrade.

Demolition and removal shall include but not be limited to items such as buildings, drainage structures, pipes, pavements, fences, retaining walls, guard rails, and signs.

Items such as fences, drainage structures, streetlighting, signing and guard rails shall be salvaged and relinquished to the appropriate owner or relocated, where indicated on the Plans.

Relocation of signs, fences, guardrails, etc. shall be considered incidental to removal work except where such relocation is listed separately in the Contract Documents.

All pipes which are to be abandoned shall be removed unless otherwise shown on the Plans or approved by the City.

E. Trees: Vegetative growth 6 inches in diameter and larger, measured 3 feet above ground shall be classified as a tree.

F. Brush: Vegetative growth less than 6 inches in diameter, measured 3 feet above ground shall be classified as brush.

G. Current Edition:

- For Capital Improvement Projects contracted by the City, the date of KDOT and MoDOT specifications in effect on the date of Construction Bid documents advertised for bids as shown in the Invitation to Bid.
- For public infrastructure constructed through privately contracted work, and privately funded, the approval date of engineering plans for public infrastructure.

2101.4 Construction

A. Erosion and Sediment Control: Comply with Section 2150 Erosion and Sediment Control. The Contractor shall not occupy any portion of the Project Site prior to the date established in the Notice to Proceed without prior approval of the Owner.

B. Limits of Work: The limits for clearing, grubbing, and demolition shall extend to the construction limits unless otherwise shown on the Plans. Contractor shall do all clearing necessary for performance of their work and shall confine their operations to that area provided through easements, licenses, agreements and rights-of-way. The Contractor's entrance upon any lands outside of that area provided by easements, licenses, agreements or public rights-of-way, shall be at the Contractor's sole liability.

In the event construction limits have not been indicated on the Plans, the limits for clearing, grubbing, and demolition shall not extend beyond the limits of the Owner’s property, right-of-way, or easements.

C. Protection of Greenery, Existing Structures and Private Facilities: The Plans will designate trees, shrubs or other plants that are to be saved and the Contractor will take necessary steps to protect this greenery. All reasonable effort shall be made to save as many trees as

possible. If trees can be saved by trimming, this shall be done in accordance with acceptable pruning practices. Trees may be pruned, upon prior approval of the City, but only in accordance with the best practices of arboriculture in respect to the individual species with due regard to their natural form and growth characteristics.

Small Plants and Flowers: At least two weeks prior to the start of construction, property owners shall be notified by the Contactor of the proposed starting date. The purpose of this notification is so that the property owners can remove any small plants or flowers that they, the property owners, desire to save.

Existing structures within or adjacent to the construction limits that are not to be removed or demolished, shall be protected by the Contractor during their construction. Any private facilities such as house sewer laterals which are disturbed or damaged by the Contractor's work, shall be repaired by the Contractor prior to the close of the work day. This repair shall be made in a manner sufficient to restore utility service to that property.
Restoration of utilities damaged by the Contractor shall be restored as directed by the utility company at no additional cost to the Owner. Unless otherwise provided in Basis of Payment no separate or additional payment will be made for any work in connection with removal, relocation or restoration of obstructions and existing facilities.

D. Surface Obstructions: Natural obstructions, existing facilities and improvements encountered during site preparation shall be removed, relocated, reconstructed or worked around as herein specified. Care shall be used while performing site preparation work adjacent to any facilities intended to remain in place. Except as otherwise specified, the Contractor shall be responsible for any damage to existing facilities and improvements and any repairs required shall be promptly made at the Contractor's expense. Waste materials shall be disposed of in a satisfactory manner off the work site.

E. Surface Obstructions for Pipeline Trenches: Sidewalks, curb and gutter, drainage structures and similar obstructions shall be tunneled under if tunneling is best suited, otherwise the obstruction shall be cut in straight lines and removed to the nearest construction joint. In no case shall the joint or line of cut be less than one foot outside the edge of the trench. Surface obstructions removed to permit construction shall be reconstructed as specified and to the dimensions, lines and grades of original construction.

F. Borrow Areas: All stumps, roots and other objectionable matter shall be removed from the borrow material used for embankment or fill. The borrow area shall be left in a well-drained and smooth condition.

G. Backfilling the Site: All trenches, holes, pits, and basement areas resulting from the operations of clearing, grubbing, demolition and removal on the site, shall be backfilled with suitable material placed and compacted in conformance with applicable sections of these specifications.

H. Disposal of Materials: All materials with the exception of those which are designated for salvage or which are used in the embankment in conformance with this specification, shall become the Contractor's property and shall be disposed of by Contractor, outside the project limits, unless otherwise indicated on the Plans. The disposal of waste and excess excavated materials, including hauling, handling, grading, and surfacing shall be a subsidiary obligation of the Contractor. The Contractor shall obtain a written Waste Disposal Agreement from property owners receiving waste materials from project. The Contractor shall provide a copy of the waste disposal agreement to the City.

I. Hazardous Materials

1. In the event hazardous waste as defined by the Resource Conservation and Recovery Act of 1976 (PL94-580) are encountered, work shall be halted and the Owner shall be notified. Work shall be resumed only after the Owner notifies the Contractor. Regulation of removal, handling and disposal of hazardous wastes is the responsibility of Federal and State agencies.

2. All other items classified as "hazardous" shall be disposed of in accordance with the applicable codes. The Contractor shall refer to Section 2150 entitled "Erosion and Sediment Control".

J. **I**tems to be Left in Place: In removing items such as concrete pavements, curbs, curb and gutter, sidewalks and similar objects where portions of these objects are to be left in place they shall be removed to an existing joint or a new joint, sawed to a minimum depth of 2 inches or ¼ the slab thickness, whichever is greater. This joint shall be to true line and vertical face. Sufficient portions of such items shall be removed to provide the proper grade and connection to the new work.

K. Mailboxes: Mailboxes shall be maintained in the manner that the Postal Service requires to prevent interruption of mail delivery.

L. Fences: Refer to Section 2307 for fencing.

M. Property Pins: The Contractor shall preserve all property corners, pins or markers. In the event any property corners, pins, or markers are removed by the Contractor, such property points shall be replaced at the Contractor's expense and shall be reset by competent surveyors properly licensed to do such work. In the event such points are section corners or Federal land corners, they shall be referenced and filed with the appropriate authority.

N. Subsurface Obstruction of Pipeline Trenches: Where existing utilities and service lines are to be encountered, the Owner thereof shall be notified by the Contractor at least 48 hours (not including weekends and/or holidays) in advance of performing any work in the vicinity. All excavation, pipeline installation and backfilling work in the vicinity of such utilities shall be accomplished in the manner required by the respective Owner and, if requested,

under their direct supervision. The Contractor shall be responsible for any and all damages to a public or private utility that may occur as the result of the construction.

The Contractor shall make a reasonable effort to ascertain the existence of obstructions and shall locate obstructions by digging in advance of machine excavation where definite information is not available as to their
exact location. Where such facilities are unexpectedly encountered and damaged, responsible officials and other affected utilities shall be notified and arrangements made for the prompt repair and restoration of service.

SECTION 2102 GRADING

2102.1 Scope

This section governs the furnishing of all labor, materials, and equipment required to excavate, place, remove, dispose or compact materials encountered within the limits of the project as shown on the Plans and in accordance with the Standard Drawings, the specifications, and the Special Provisions.

2102.2 Definitions

The following terms have the meanings indicated:

A. Grading: Grading as used herein shall mean the performance of all excavation, embankment, and backfill in connection with the construction of all improvements.

B. Excavation: Excavation is defined as the removal of materials from the construction area to the lines and grades shown on the Plans and includes trenching for pipelines, utilities, and structures.

1. Unclassified Excavation: Unclassified excavation is defined as the removal of all material encountered regardless of its nature. All material excavated will be considered as Unclassified Excavation unless otherwise specified in the Contract Documents.

2. Rock Excavation: Rock excavation is defined as the removal of all rock ledges 6 inches or more in thickness, and detached rock or boulders having a volume of more than 1 ½ cubic yards and shale occurring in its natural state, hard and un-weathered.

    a. A rock ledge is defined as a continuous body of rock which may include thin interbedded seams of shale or other soft materials less than 12 inches thick. The vertical limit of each ledge shall be defined by interbedded seams of soft materials 12 inches or more in thickness. The beds of soft interbedded material 12 inches or more in thickness shall not be included

in the measurement for "Rock Excavation" but shall be included in the measurement for "Earth Excavation".

b. The following items shall not be considered as rock excavation: soft or disintegrated rock or flowable backfill (CLSM) which can be removed with a pick or digging machine; loose, shaken or previously blasted rock; broken stones and rock which may fall into the trench from outside the limits of excavation.

c. When solid rock (including non-diggable flowable backfill (CLSM)) is unexpectedly discovered, the Contractor shall notify the Owner.

3. Earth Excavation: Earth excavation is defined as the removal of all material not defined as rock.

4. Trench Excavation: Trench excavation is defined as excavation to the width and depth as necessary to lay the pipe, set structures, make utility connections, and/or install appurtenances to the grade line as indicated on the Plans and in the specifications.

5. Tunneling, Boring and Jacking: Includes all underground horizontal excavations necessary to install pipes and/or conduits to the grade line as indicated on the Plans and in the specifications.

C. Trench Foundation: The area at the bottom of the excavation shall be composed of a stable material capable of supporting the placement of bedding material, pipe, or structures.

D. Unstable Foundation: Materials encountered in the bottom of the trench deemed as unsuitable by the Engineer to afford a sufficiently stable pipe foundation.

E. Flowable Backfill / Controlled Low Strength Material (CLSM): A mixture of portland cement, fly ash (optional), fine aggregate, water, and admixtures (as approved by the Engineer) proportioned to a consistency to fill voids without vibration. Flowable Backfill (CLSM) shall consist of:

1. Cement: The portland cement shall conform to ASTM C 150, Type 1 or Type II.

2. Fly ash: Fly ash, when used, shall conform to the requirements of ASTM C 618 Class C or F.

3. Fine Aggregate: Fine aggregate shall conform to ASTM C 33.

4. Mixing Water: Mixing water shall conform to ASTM C 1602.

5. Admixtures: Air entrainment, when used, shall conform to ASTM C 260. Water reducing admixtures, when used, shall conform to ASTM C 494. All

other admixtures shall only be used when approved by the Engineer.

6. Other materials: Proposed replacement or supplementary materials shall be approved by the Engineer and in conformance with current NRMCA or ACI guidelines for CLSM.

Flowable Backfill (CLSM) compressive strength testing results are required for approval of mix design prior to placement of flowable backfill. Compressive tests are to be conducted at 7 and 28 days in accordance with ASTM D 4832. CLSM shall have a minimum and maximum 28-day design compressive strength of 50 psi and 125 psi, respectively. The unit weight of the CLSM shall be a minimum of 125 lbs. per cubic foot (pcf). All tests necessary for determining conformance with the requirements specified herein will be at the Contractor's expense.

F. Bedding: The placing and compacting of the aggregate material above the stable foundation and below the pipes or structures.

G. Embedment: The placing and compacting of approved material surrounding the pipe up to a maximum of 12- inches above the top of pipe.

H. Embankment or Backfill: The placing and compacting of approved material in the construction areas to the lines and grades shown on the Plans.

1. Unsuitable Material: Frozen material, organic material, top soil, or rubbish. Top soil is unsuitable for embankment and backfill, but may be used as the surfacing for graded areas to be seeded or sodded (see Section 2400).

    a. Embankment Materials: Rock Embankment: Material for rock embankment shall be free of unsuitable material and shall contain, by volume, greater than 10 percent rock or gravel having a maximum dimension greater than 3 inches but not greater than 24 inches.
    b. Earth Embankment: Material for earth embankment shall be free of unsuitable material and shall, contain by volume, less than 10 percent rock or gravel having a maximum dimension greater than 3 inches.

2. Backfill: Backfill materials shall be furnished and installed to complete the work shown on the Plans or as called for in the Contract Documents.

    a. Select Earth Backfill Material: Select earth backfill shall be finely divided job excavated material free from debris, organic matter, rocks larger than one (1) inch and/or frozen materials.
    b. Other Earth Backfill: Other backfill may be job excavated material free from debris and organic matter. No rock greater than three-inches in diameter shall be placed in any trench excavation as backfill unless approved by the Engineer.
    c. Aggregate Backfill Material: Approved material meeting ASTM C33

requirements and the specified gradations.

d. Flowable Backfill (CLSM): See Section 2102.2.E.

I. Borrow: Approved material excavated from an area outside of the project limits and required for the construction of the embankment. Borrow material shall be free of organic material, top soil, rubbish, frozen material, or saturated materials. Imported borrow that is soil shall meet the following: the portion passing the No. 40 Sieve having a liquid limit not exceeding 50 and a plastic index not exceeding 25, when tested in accordance with ASTM D 4318.

J. Waste: Waste is defined as excavated material not used on the project and disposed of outside of the construction limits as shown on the plan, to include off site at a location established by the Contractor, or a specified disposal area shown in plans.

K. Structures: Used herein refers to culverts, storm sewer and/or sanitary appurtenances, underground vaults, and similar construction. See Section 2700 for other structures.

2102.3 Construction

A. The Contractor shall adhere to any and all statutes regarding the notification of utilities prior to beginning any work within public right-of-way. The relocation and/or protection of any utility that is shown on the Plans, that lies within a utility easement and is endangered by this construction shall be the responsibility of the Contractor.

B. The Contractor shall make every reasonable effort to protect private facilities. These facilities may not be shown on the Plans. When these facilities are disturbed or damaged by the work, the Contractor shall make necessary arrangements for repairs to the facilities for continuous service prior to the close of that work day.

C. It shall be the responsibility of the Contractor to protect all property lot corners and control monumentation. Should it be necessary to disturb any such monument, whether stake, pin, bar, disk, box, or other, it remains the responsibility of the Contractor to reference such markers prior to removal, reset them, and file such relocations or monumentation documents as the law may require. Any such references, removal, replacement and certification of monuments shall be performed by a registered licensed surveyor. A copy of all such certification documents shall be provided to the Owner prior to final payment. Any monument destroyed or improperly reset by the Contractor may be replaced by the Owner to the standards required by law at the expense of the Contractor.

D. Grading, excavation, and backfilling for all improvements, shall be made to the lines, grades, and cross sections
indicated by the Plans.

E. In addition, to any erosion control measures shown on the Plans, the Contractor shall schedule and conduct their operation in such a manner and shall provide any necessary

control facilities to protect downstream and adjacent properties from pollution, sedimentation, or erosion caused by the grading operations. Any pollution or damage occurring shall be the responsibility of the Contractor. See Section 2150 Erosion and Sediment Control.

F. During construction, the graded area shall be maintained by the Contractor in such condition that it will be well drained at all times. Roadway ditches, channel changes, inlet and outlet ditches and other ditches in connection with the roadway shall be cut and maintained to the required cross section. All drainage work shall be performed in proper sequence with other operations. All ditches and channels shall be kept free of debris or obstructions not identified in the erosion control plan.

G. All suitable material removed by excavation shall be used as far as practicable and as required to complete the work. The Contractor shall sort all excavated material and stockpile when necessary, so as to provide suitable materials for embankments, backfill, or other earthwork.

H. After removal of the roadway excavation material to the required elevations, all material between lines 1 foot outside of the curbs and within the top 6 inches of the subgrade shall be scarified, moisture conditioned and re-compacted to 95 percent of maximum density within 1% below optimum moisture content to 4% above optimum moisture content for the material as defined in Section 2102.6.F.

I. Rock encountered within the full width of the roadway, toe of slope to toe of slope, shall be undergraded to an elevation of 6 inches below the finished subgrade elevation. Care shall be taken to avoid overshooting when blasting. Rock shall be removed in such a manner as to leave no excessive water pockets in the surface.

J. Blasting: When blasting is permitted by the City, the Contractor shall use the utmost care to protect life and property. The Contractor shall obtain any required permits from the agency having site jurisdiction and shall comply with all laws, ordinances, and the applicable safety code requirements and regulations relative to the handling, storage and use of explosives and protection of life and property, and he shall be responsible for all damage caused by his or his subcontractor's operations.

1. The Contractor shall provide insurance as required by the Contract Documents before performing any blasting. The governing agency shall be notified at least 24 hours before blasting operations begin.

K. No Blasting Areas: No blasting of any kind for rock excavations or any other purpose will be allowed unless noted otherwise on the Plans or permitted by the City.

L. Areas of undergrading or overbreakage in rock between lines 1 foot outside of the curbs shall be backfilled with spalls, rock fragments or a granular type material. Backfill materials shall have a plasticity index not to exceed 10 and a gradation such that at least

50 percent of the material will be retained on the No. 4 Sieve.

M. Cribbing and Sheeting: The Contractor shall furnish, install, and maintain such sheeting, bracing, and other components, as may be required to support any excavation and to prevent any movement which could in any way injure or delay the work or endanger adjacent pavement, building, or other structures. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed they shall be immediately filled and consolidated.

For the purpose of preventing injury or property damage, Contractor may leave in place all sheeting or bracing,
and other items to be embedded in the backfill of the trench. No sheeting or bracing, however, shall be left in place within 5 feet of the surface without the written permission of the Engineer.

2102.4 Excavation, Trenching, And Backfilling

A. Dewatering of Excavation

1. The Contractor shall maintain a dry and stable excavation, obtain necessary permits, and provide for the proper method of discharging water from the work site at all times until installation is completed.

2. The Contractor shall not allow hydrostatic pressure flotation or other adverse effects to cause damage to the structure or pipeline.

3. Proper dewatering techniques are the Contractor's responsibility. All work performed by the Contractor that is adversely affected by his/her failure to adequately dewater trenches will be subject to rejection by the Engineer. The Contractor shall repair and/or replace affected structures or pipelines.

4. The Contractor shall remove any water that may accumulate or be found in the trenches and other excavations made as part of the work.

5. Grading shall be done to prevent surface water from flowing into trenches or other excavations, and to maintain the flow of water in natural watercourses on or adjacent to the site. Any water accumulating in trenches or other excavations shall be removed by pumping or by other approved methods.

B. Trench Excavation: Trenches shall be excavated to the width and depth as necessary to lay the pipe to the grade line as indicated on the Plans with proper pipe embedment. The Contractor shall perform excavation of materials encountered in accordance with Section 2102.3, regardless of material type, to the depths indicated on the drawings or as otherwise specified herein. Excavated materials are to be deposited outside trenches and excavations to avoid overloading, and to prevent slides or cave-ins, transported to the spoil banks, or

used for backfilling. All excavated materials not required or not suitable for backfill shall be removed and disposed of off the site by the Contractor as part of the Work. The trench excavation opened at one time shall be limited by the nature of the soil and other safety considerations.

1. All excavation work shall be accomplished under the supervision of a person employed by the Contractor or his subcontractor and experienced with the materials and procedures which will provide protection to existing improvements, including utilities and the proposed pipeline.

2. The alignment, depth, and pipe subgrades of all trenches shall be determined by a laser beam parallel to the pipe invert.

3. Deviation from the indicated alignment will not be permitted except under special circumstances, subject to approval of the Engineer.

4. Trenches that are parallel to structures, pavements or walls shall be no closer than 18 inches from the closest edge of footings or pavement. Also, no parallel trench shall extend in depth below a plane having a downward slope of 1 horizontal to 2 vertical starting from a line 9 inches above the bottom edge of footings or pavement. The bottom of pavement shall be the lowest improved section of pavement to include chemically stabilized subgrade or aggregate base layers.
5. When pipe is to be installed in embankment or fill, the embankment shall be constructed in accordance with APWA section 2102.6 and shall be built up to a plane at least 18 inches above the top of the pipe prior to the excavation of the pipe trench.

6. The Contractor shall not open more trench in advance of pipe laying than is necessary. Four hundred (400) feet will be the maximum length of open trench allowed on any line under construction. All open trenches shall be adequately protected.

7. Undercutting of trench walls is not permitted.

8. Option to Trenching: Contractor may perform excavation by tunneling methods as set forth herein at no additional cost to the Owner provided prior written approval for each such location is obtained from the Engineer. The Contractor shall submit to the Engineer, prior to actual work, a written description of his proposed operation. It shall include the types and locations of shafts, methods to provide safe support strength for the pipeline when the shafts or bore pits exceed maximum allowable trench widths and other features that would affect the pipeline. Tunneling shall be done with a minimum inconvenience and disturbance to the general public and abutting property owners.

C. Trench Widths: Trenches shall be excavated to a width that will provide adequate working space and pipe clearances for proper pipe installation, jointing, and

embedment. Over-excavation shall be replaced with granular bedding material or flowable backfill (CLSM). See applicable Plans, Standard Drawings, and manufacturers' recommendations for trench widths for pipe installations.

D. Preparation of Trench Foundation: The Trench Foundation shall be prepared to provide uniform and continuous support of pipe. The trench bottom shall be evenly graded. Areas that are too high shall be shaved as required. Any portions of the trench that are found to be too low shall be filled with suitable materials, thoroughly compacted, and brought to true grade, allowing for placement of bedding material as shown in the Standard Drawings.

E. Trench and Structural Excavation Foundation in Rock Excavation: Where rock is encountered in excavation, the rock shall be removed to provide a minimum clearance of 6 inches below and 6 inches along each side of the pipe.

F. Replacement of Unsuitable Pipe Foundation Material

1. If unstable subgrade conditions are encountered and it is determined by the Engineer that the excavation bottom will not provide suitable support, the Contractor shall remove all unstable or unsuitable material over the entire width of the trench to the depth required by the Engineer to provide a stable Trench Foundation. Removal shall not be less than 6 inches.

2. Materials so removed shall be replaced with bedding aggregate material as specified herein. Bedding material shall be mechanically compacted over the entire width of the trench and shall be brought to proper grade, shape, and elevation for the installation of the pipe as shown on the Plans or Standard Drawings.

G. Excavation Foundation Soils for Structures

H. Granular Bedding Materials: Granular bedding material shall meet ASTM C33 with one of the following gradation requirements:

Storm Sewer, Sanitary Sewer, or Water Main Pipe Bedding Material Gradation Limits (% Passing)			
Sieve Size	3/4"	1/2"	3/8"
1"	100		
3/4"	90 – 100	100	
1/2"		80 – 100	
3/8"	20 – 55	40 – 77	100
No. 4	0 – 10	0 – 15	30 – 40
No. 8	0 – 5	0 – 5	0 – 4

Optional Waterline Bedding Material Gradation (% Passing)				
Sieve Size	Type 1 (1/2”)	Type 2 (Buckshot)	Type 3 (Man. Sand)	Type 4 (River Sand)
3/4"	95 – 100			
3/8”	40 – 60	100	100	
1/4"			90 – 100	
No. 4		60 – 80	85 – 90	100
No. 8	0 – 5	0 – 15	35 – 75	
No. 50			10 – 25	
No. 200		0	0 – 10	0 – 10

I. Pipe Embedment: All water, sanitary sewer, and storm sewer pipe shall be bedded in bedding aggregate as specified herein.

1. Bedding shall cover the entire width of trench.

2. The first layer of bedding placed on the bottom of excavation shall be in accordance with City of Lee’s Summit Standard Detail GEN-6.

3. Bedding at bottom of trench, in the middle 1/3 of trench under the pipe shall be loose.

4. Second layer of bedding material shall be placed under the lower haunches of the pipe up to the springline (center of pipe). Material shall be spaded to be place under haunches and then densified by tamping or spading at the springline elevation prior to placing additional bedding material.

5. The third layer of bedding material shall be placed to 6 inches over the top of pipe and compacted in a manner that will not damage the pipe.
6. The fourth layer of bedding material shall be place to 12 inches of the top of pipe and compacted prior to placing trench backfill material.

7. Contractor shall take measures to prevent pipe from floating or sagging during placement of bedding material so that pipe maintains proper line and grade as shown on the Plans.

J. Trench Backfill

1. Backfill shall not be placed when material contains frost, is frozen, or a blanket of snow prevents proper compaction.

2. The Contractor shall remove from the project site waste material, trees, organic material, rubbish, or other deleterious materials.

3. All trash and debris shall be removed from the pipeline excavation prior to backfilling.

4. Backfill material shall be carefully placed to avoid damage to or displacement of the pipe, other utilities or structures.

5. Unless otherwise specified, all trenches and excavations around structures shall be backfilled to the original ground surface.

6. Narrow Trench Backfill: Suitable backfill material for trenches 24 inches or less in width and shall be flowable backfill (CLSM).

7. Backfill Around Structures: CLSM shall be used to backfill around structures, such as manholes, inlets, junction boxes, vaults, etc. CLSM shall be place the full depth of the trench backfill zone, but shall be at least 6 inches below the bottom of prepared subgrade under pavements or 12 inches below the ground surface in landscaped areas. The external opening surfaces of weep holes shall be covered with hardware cloth and surrounded with a minimum of three cubic feet of consolidated granular bedding material..

8. The method of compaction and the equipment used shall be appropriate for the material to be compacted and shall not transmit damaging shocks to the pipe.

9. The backfill material shall be place in layers not exceeding 8-inches in loose lift thickness and be compacted to at least 95% of maximum density. A minimum of one compaction test shall be taken every 200 to 400 linear feet for each lift of backfill (or A minimum of one compaction test shall be taken every 100 to 200 cubic yards of backfill compacted in place.)

10. Testing shall be performed by a qualified testing lab hired by the Contractor and approved by the Owner.

11. Laboratory compaction test and index property test results for each material used on site shall be submitted to the City prior to construction. Any work by Contractor prior to test submittals and subsequent Owner review and approval shall be work done at the Contractor's risk.

12. Field Density Test reports shall be submitted to the City daily. The reports shall clearly indicate the location of all tests by street name, station and/or lot number, type of backfill material, utility type, and depth of test. The reports shall include the results of all tests (pass or fail) and all re-tests.

13. All test reports shall be submitted prior to receiving approval of subgrade for curb and pavement installation. Pavement, curb or other surface features placed prior to receiving subgrade approval shall be placed at the Contractor's risk.

K. Flowable Backfill (CLSM) Installation

1. Flowable Backfill (CLSM) shall be constructed to the configuration and the lines and grades shown on the Plans, or as directed by the City. No additional payment will be allowed for placement beyond these limits.

2. The producer may cut back on the quantity of water incorporated during batching with the approval of the City. Additional water may be added on-site to achieve the intended consistency. The final mix unit weight and compressive strength shall fall within the specified ranges as described in Section 2102.2.E.

3. No Flowable Backfill (CLSM) shall be placed on frozen ground or in standing water.

4. When the ambient temperature is either falling or forecasted to fall below 35^{o} F within 24 hours of its proposed placement time, the Contractor may submit the use of cold weather methods for approval by the Engineer.

5. Care shall be taken to prevent the movement of any conduit, pipe or structure from the designated location or intrusion of flowable backfill into undesirable locations. If such movement or intrusion occurs, the Engineer may require the affected structure to be excavated and replaced to the proper grade at the Contractor's expense.

6. If flowable backfill is placed in more than one layer, loose and foreign material shall be removed prior to placing the next layer.

7. No flowable backfill shall be covered or accepted until a minimum compressive strength has been attained, as demonstrated by failure to deform or crush underfoot. If the flowable backfill does not harden to required strength, the flowable backfill shall be removed and replaced with an acceptable material at the Contractor’s expense. Acceptance of the flowable backfill shall be based on visual inspection.

8. Random compressive strength testing may be conducted at the Owner’s expense to verify compliance with strength requirements. Compressive tests shall be in accordance with ASTM D 4832.

L. Trench Checks

1. Install where shown on the Plans.

2. The backfill above the trench check shall meet the specifications for backfill material.

M. Excavation by Tunneling or Boring: Where depth of trench and soil conditions will allow it, tunneling may be required under pavement, railroad tracks, or other surface structures. Tunnel sections shall provide adequate clearance for pipe and workers for proper lining, grading, and jointing the pipe installed therein.

All tunnel excavation shall provide an excavation conforming to the outside diameter of the casing and/or carrier conduit. The excavation shall be to an alignment and grade which will allow the carrier conduit to be installed to proper line and grade as shown on the Plans and as established in Section 2505.2.H. Conduct excavation in a manner to prevent disturbing overlying and adjacent material. Perform dewatering and chemical soil stabilization or grouting if necessary, due to existing field conditions.

N. Settlement: The Owner may perform periodic inspections to insure that no settlement has occurred. The Contractor shall be responsible for all settlement of backfill, fills and embankments which may occur within two
(2) years of time after final acceptance of the contract under which the work was performed.

The Contractor shall make, or cause to be made, all repairs or replacements made necessary by settlement within thirty (30) days after notice from the Owner. Should the Contractor fail to make such repairs the Owner may cause repairs to be made and the cost of these repairs shall be the responsibility of the Contractor.

O. Excavation and Backfilling Structures

1. All structure foundations shall be founded on stable, undisturbed subgrade. Excavation shall be sufficient to provide at least 12 inches clear between the outer surfaces of the structure (including formwork) and the embankment or timber that may be used to hold and protect the excavation.

2. Unsuitable or unstable foundation soil that will not properly support the structure, as determined by the Engineer, shall be removed to the depth required and the excavation backfilled to the proper grade with compacted bedding material or other material approved by the Engineer.

3. All excavations for structure shall be kept dry; no reinforcing steel shall be installed in water; and no water shall be permitted to inundate the reinforcing steel before concrete has been placed.

4. CLSM shall be used to backfill around structures, such as manholes, inlets, junction boxes, vaults, etc. CLSM shall be place the full depth of the trench backfill zone, but shall be zero to six inches below the bottom of prepared subgrade under pavements or 12 to 18 inches below the ground surface in landscaped areas. The external opening surfaces of weep holes shall be covered with hardware cloth and surrounded with a minimum of three cubic feet of consolidated granular bedding material.

5. Backfilling

a. No backfill shall be placed over or around any structure until the concrete or mortar therein has attained a minimum strength of 2000 psi and can sufficiently support the loads imposed by the backfill without damage.
b. The Contractor shall use utmost care to avoid any wedging action between the side of the excavation and the structure that would cause any movement or floating of the structure. Any damage caused by premature backfill or by the use of equipment on or near a structure will be the responsibility of the Contractor.
c. Backfill shall be placed and compacted on all sides of the structure simultaneously, and operations shall be so conducted that the backfill is always at approximately the same elevation on all sides of the structure.
d. No excavated rock larger than 3 inches maximum dimension shall be placed within 1 foot of the exterior surface of any structure except as allowed with flowable backfill (CLSM) placement.
e. No backfill material containing rock, or detritus from rock excavation, shall be placed in the upper 24 inches of the excavation.
f. Large rock may be placed in the remainder of the backfill upon approval of the Engineer. Approved rock material shall be placed so that it is well separated, allowing proper compaction of soil backfill around the rock material.
g. All excavation shall be backfilled to the lines and grades shown on the Plans.
h. After the required curing time, backfill shall be placed and compacted in layers. Contactor shall monitor impact of placement, vibration and related work so not to damage or disturb structures.
i. Backfill shall be place in compacted in layers not exceeding 8-inches in loose thickness and be compacted to at least 95% of maximum density within 1% below optimum moisture content to 4% above optimum moisture content as determined by ASTM D 698. Each lift shall be compacted and tested to the required density prior to the next lift being placed. Testing shall be performed by a qualified testing lab hired by the Contractor and approved by the Owner.
j. In no instance shall backfill be dumped, bulldozed, or otherwise deposited in bulk upon the newly constructed structure.

P. Backfill of Drainage Course Crossings

1. Excavation in rock to a distance of 10 feet beyond each bank (measured perpendicularly to the stream flow) shall be backfilled with concrete to the existing rock elevation. The excavation above the rock elevation shall be backfilled with soil above that concrete encasement or as indicated on the Plans.
The soil placed above the encasement shall be compacted to at least 95% of maximum density within 1% below optimum moisture content to 4% above optimum moisture content as determined by ASTM D 698.

2. Pipe placed in an excavation in soil shall be encased in concrete to a minimum of 1 foot above and below the pipe and backfilled with soil above that concrete encasement or as indicated on the Plans. The soil placed above the encasement shall be compacted to at least 95% of maximum density within 1% below optimum moisture content to 4% above optimum moisture content as determined by ASTM D 698.

2102.5 Undergrading

A. Where materials are encountered which are deemed as unsuitable by the Engineer for use in the work, they shall be removed to the depth and limit as ordered by the Engineer. Areas undergraded shall be backfilled with one of the following materials:

1. Replacement with suitable materials from excavation on the work site or from an off-site borrow area, compacted to the required moisture and density requirements where practicable.

2. Mixing of stone base or rock materials, hydrated lime, portland cement or fly ash into the sub-grade.

3. Placement of compacted aggregate.

4. Rock fragments or spalls. A granular type material having a plasticity index not to exceed 10 and a gradation such that at least 50 percent of the material will be retained on the No. 4 Sieve and not more than 40 percent will pass the No. 10 Sieve.

5. A material meeting the requirements of Section 2102.2.H.2.

2102.6 Embankment

A. This section governs embankment for all improvements. The embankments shall be constructed using suitable materials, as herein defined, procured from excavations made on the project site or from borrow areas as required to complete the grading work.

B. Starting the Embankment: Where embankments, regardless of height, are placed against hillsides or existing embankments, either of which have a slope steeper than 1 vertical to 4 horizontal, the existing slope shall be benched or stepped in approximately 24 inch rises as the new fill is brought up in 8 inch maximum layers or lifts. The material bladed out, the bottom of the area cut into, and the embankment material being placed, shall be compacted to the required density. Material cut out, bladed into place and compacted shall not be measured and paid for directly but will be considered as incidental work.

The existing surface upon which embankment material is to be placed shall have all unstable and unsuitable material removed before starting the embankment work. Where embankments 2 feet or less in depth are to be placed on areas covered by existing pavement, the existing pavement shall be removed and the cleared ground surface shall be compacted to the specified density. Where embankments greater than 2 feet in depth are to be placed on areas covered by existing pavement, the existing pavement shall be broken into pieces no larger than 18 inches maximum dimension, left in place and the embankment started thereon.

C. Placing Earth Embankment: Earth shall be placed in successive horizontal layers distributed uniformly over the full width of the embankment area. Each layer of material shall not exceed 8 inches maximum in thickness (loose state) and shall be compacted to not less than the required density before the next layer is placed thereon. As the compaction of each layer progresses, continuous blading, or dozing will be required to level the surface and to ensure uniform compaction. Embankment construction shall not be performed when material contains frost, is frozen or is snow covered.

D. Placing Earth and Rock Embankment: When earth and stone or rock fragments are mixed in the embankment, all stones or rock fragments exceeding the thickness of the compacted lift shall be disposed of by being incorporated into the embankment outside the limit of the proposed paved areas. The thickness of the layer in these areas may be increased if necessary to accommodate the rocks, but shall not exceed 12 inches in thickness (loose state). The stones or rock fragments are to be placed so there will be no nesting.

E. Consolidated Rock Embankment: When the excavated material consists predominantly of stone or rock fragments of such size that the material cannot be placed in layers of the thickness prescribed, such material shall be placed in the embankment in layers having a thickness of the approximate average size of the larger rocks but not to exceed 24 inches. Rocks or boulders too large to permit placing in a 24 inch layer shall be reduced in size as necessary to permit placement. Rock shall not be dumped in place but shall be distributed by blading or dozing in a manner to insure proper placement in final position in the embankment. Voids shall be filled with smaller stones, earth, sand, or gravel. Each layer shall be thoroughly consolidated before the next layer is placed.

The upper layer of rock shall be filled with a 6-inch thick layer of 3/4-inch choker stone prior to placing soil material.

Rock embankment shall be capped with 3 feet of soil material on all sides. The soil cap material shall not contain material having a maximum dimension greater than 3 inches.

F. Compacting the Embankment: Before placing any embankment, the surface of the existing ground shall be prepared as specified herein, moistened as required, and the top 6 inches compacted to a density of 95 percent as prescribed by the following paragraph:

All embankment shall be compacted to a density of at least 95 percent of the maximum density for the material used as determined by ASTM D 698 with a moisture range sufficient to allow for proper compaction. In addition to the above required compaction, the subgrade between lines 1 foot outside of the curbs and within the top 6 inches of the subgrade in cut sections and the top 18 inches in fill sections shall be compacted to a density of at least 95 percent of the maximum density for material used and within 1% below optimum moisture content to 4% above optimum moisture content , as determined by ASTM D 698.

All work involved in either adding moisture to or removing moisture from embankment materials to within these moisture limits shall be considered incidental to the completion of the grading operation.

G. Moisture – Density Determination: In-place density and moisture content of the embankment will be determined by an acceptable method as approved by the Engineer.

H. Testing

1. Laboratory compaction test and index property test results for each material used on site shall be submitted to the Engineer prior to placement. Any work by Contractor prior to test submittals and subsequent Engineer review and approval shall be work done at the Contractor's risk.

2. In-Place Density/Moisture tests shall be taken at the frequency of 4 per day per spread, with a minimum of one test per lift. (one test per every 500 cubic yards of material placed.)

3. Test reports shall be submitted to the Engineer daily. The reports shall clearly indicate the location of all tests by street name, station and/or lot number, type of material, and elevation of test. The reports shall include the results of all tests (pass or fail) and all re-tests.

4. All test reports shall be submitted prior to receiving approval of subgrade for subsequent work. Pavement, curb, other surface features or utilities placed prior to receiving embankment approval shall be placed at the Contractor's risk.

I. Backfilling Curb and Gutter: Backfilling behind curb or curb and gutter shall be done within seven (7) days after being laid unless otherwise approved by the Engineer. The material used to fill the void behind curb or curb and gutter shall be free of rock and debris and shall be of a type that will leave no voids to pocket water. Unless otherwise shown on the contract drawings, the finish grading from the back of the curb to the right-of-way line and/or utility easement line or construction easement line shall be performed to provide a smooth transition between existing yard grades at the right-of-way line and/or easement line to the curb so that positive drainage will exist.

The top portion of the backfill within right-of-way areas shall be finished with at least 6 inches of topsoil corresponding to, or better than, that underlying adjoining sodded areas. The upper 2 inches or more of topsoil shall be pulverized topsoil. Topsoil shall be approved by the Engineer prior to placement, and unless otherwise directed, shall be material previously excavated and stockpiled for the purpose during excavating and grading operations. Immediately prior to dumping and spreading topsoil, the surface shall be loosened by discing or scarifying to a minimum depth of two (2) inches to permit bonding of the topsoil to the underlying surface.

2102.7 Finishing

A. In areas where sodding or seeding is proposed, the upper 12 inches of the surface area shall be earth material free of rocks greater than 1 inch in diameter. The top 6 inches shall be topsoil suitable for sustaining grass or sod.

B. Except where other permit or utility work is in progress, the graded surface shall be made free of rock, concrete, and brick, or fragments thereof, or rubbish and shall be finished to the lines, grades, and cross- section indicated on the Plans, including shoulder, berm and sidewalk spaces.

C. The Contractor shall repair any damaged surface, and shall not use any finishing equipment that will leave a marred surface. When the subgrade preparation is included as a part of the finishing, the work shall be accomplished according to the requirements of Section 2201 entitled “Subgrade Preparation”, and shall be considered incidental to finishing the grading work.

2102.8 Cleanup

Cleanup shall follow the work progressively and final clean-up shall follow immediately behind the finishing. The Contractor shall remove from the site of the work all equipment, tools and discarded materials, and other construction items. The entire right-of-way or easement shall be left in a finished and neat condition. Cleanup shall be considered as incidental to the completion of grading work.

SECTION 2150 – EROSION AND SEDIMENT CONTROL

CITY OF LEE'S SUMMIT, MISSOURI
STANDARD SPECIFICATIONS

The City of Lee's Summit hereby adopts Section 2150 of the Kansas City Metropolitan Chapter of APWA Construction and Material Specifications, current edition. The following additions, deletions and/or revisions are adopted as a part of Section 2150 for use within Lee's Summit. Text in bold italics indicates revisions or additions to the APWA standard.

2154.5.A (Silt Fence) Materials, Construction Requirements, and Maintenance:

ADD the following:

1. ***Silt fence typically should not be used in swales, drainage-ways, channels and other conduits of concentrated stormwater flow and will only be considered on a case by case basis.***
2. ***Silt fence typically should not be used to direct or divert water and will only be considered on a case by case basis.***

DIVISION II
CONSTRUCTION AND MATERIAL SPECIFICATIONS

SECTION 2150 EROSION AND SEDIMENT CONTROL

Approved and Adopted this 15th day of February, 2017

Kansas City Metropolitan Chapter
American Public Works Association

SECTION 2151 GENERAL REQUIREMENTS

2151.1 Summary: This section describes general requirements to prevent or minimize the pollution of rivers, streams, lakes, and wetlands caused by runoff from the construction zone. Such pollution includes sediment that may migrate offsite through the action of wind, water, or traffic, as well as chemical spills or other refuse from the site.

2151.2 Contractor's Responsibility: The Contractor shall take measures to prevent or minimize the transport of sediment or pollutants from the project limits or into bodies of water that are intended for protection, in accordance with the plans, the requirements of applicable permits and regulations, and best available management practices.

2151.3 Compliance with NPDES Permits: The Owner will obtain a National Pollutant Discharge Elimination System (NPDES) permit and other similar local water pollution control permits as required. Where such permits are required, the Owner will provide the Contractor with a Stormwater Pollution Prevention Plan (SWPPP) which has been prepared by the Engineer or other qualified professional. The Contractor shall comply with all requirements of such permits and the SWPPP, and shall enforce compliance with such requirements by all Subcontractors. The Contractor shall complete the required certification forms for coverage under the relevant permit and shall notify all Subcontractors in writing of the requirements of the SWPPP, obligate them under contract to comply, and enforce compliance during the work.

2151.4 Projects Not Requiring a Permit: If neither NPDES permit nor other local water pollution control permits are required for a project, the Engineer may waive certain documentation and record-keeping provisions of this specification. The Contractor is required to comply with all other provisions in this specification and is required to install such measures for erosion and pollution control as may be called for in the plan or ordered by the Engineer.

2151.5 Stormwater Pollution Prevention Plan (SWPPP): The Stormwater Pollution Prevention Plan (SWPPP) outlines methods and controls to be used to prevent stormwater pollution from the construction activities.

The SWPPP will generally consist of the following elements: (a) a site description; (b) a site map or plan sheets showing areas of soil disturbance, an outline of areas which will not be disturbed, and a drainage area map; (c) plan sheets, tables, or other schedules detailing the location of major structural and non-structural controls and areas where stabilization practices are expected to occur; (d) a description of erosion and sediment controls to be used; (e) a description of any permanent stormwater management features which are incorporated into the project; (f) a description of other controls related to waste disposal practices; (g) a description of the timing, during the construction, of when the measures will be implemented and removed; and (h) a description of maintenance procedures for control measures identified in the plan.

Where multiple agencies have jurisdiction over erosion and sediment control, the SWPPP will be prepared to satisfy the requirements of each. The use of the term “Stormwater Pollution Prevention Plan” or “SWPPP” is not intended to limit its content to the provisions of any single permit program or jurisdiction, and this specification shall have the same meaning regardless of whether the applicable plans are referred to as a “SWPPP,” “erosion control plan,” “erosion and sediment control plan,” “temporary water pollution control plan,” or other equivalent term.

All elements of the project bid documents relating to erosion and pollution control are considered part of the SWPPP, either by direct inclusion or by reference, including plan sheets,

specifications, special provisions, quantity tabulations, bid sheets, and contract documents. A copy of all NPDES and other water pollution related permits and permit applications are also part of the SWPPP. This APWA specification is an integral part of the SWPPP.

2151.6 Contractor Amendments to the SWPPP: Prior to beginning work, the Contractor shall review the SWPPP in detail and provide the Engineer with written recommendations for amendments to improve the effectiveness of the SWPPP or to bring it into better alignment with the Contractor's intended method of operations. The Contractor shall also advise the Engineer of any omissions or deficiencies they find in the SWPPP. During the progress of the job, the Contractor shall continue to monitor the effectiveness and performance of the control measures used and propose additional amendments as needed. No amendment shall be incorporated unless approved by the Engineer, and a log of such amendments shall be made by the Contractor. When required by the permit or state law, such amendments shall be developed and prepared under the supervision of a qualified professional as defined in said permit or law. A copy of the SWPPP and all amendments shall be retained by the Contractor onsite and ready for inspection without notice.

2151.7 Contractor Schedule: In addition, the Contractor shall also provide the Engineer with a detailed schedule of their work prior to beginning, which shall include information on the expected timing, duration, and sequencing of erosion and sediment control measures and overall job completion and phasing. Once approved, such schedule shall become a part of the SWPPP, and changes to the schedule shall require amendment to the SWPPP.

2151.8 Alternate Methods or Materials: The Contractor may propose alternative methods or materials for any of the specific erosion and sediment controls given in the SWPPP, provided that such methods provide equal or improved measures of control, as determined by the Engineer. The Contractor shall submit any documentation required by the Engineer to evaluate the alternative. If agreed to by the Engineer (and subject to state or other permitting agency approval if applicable), payment for such alternate method shall be handled in accordance with the applicable provisions of the Contract for changes in work.

2151.9 Superintendent Training Required: The Contractor’s resident superintendent shall have no less than 8 hours of formal training on erosion and sediment control within the last 24 months. Such training shall include the principles of erosion and sediment control, technical information on typical and/or innovative controls, and the contents of these specifications and related Standard Drawings and Design Criteria. The training shall be taught primarily by a registered professional engineer or other professional who is considered by the applicable regulatory agencies to be qualified to prepare a SWPPP. Documentation of training shall be submitted to the Engineer upon request, prior to beginning work.

2151.10 Duration of Contractor's Responsibility: The Contractor is responsible for water pollution control and permit compliance from the issuance of Notice to Proceed until final completion of the work and during any subsequent maintenance bond period. The notice of termination will not be submitted by the Owner until all permit requirements are met, which includes the requirement that final stabilization be achieved on 100% of the site. Vegetation shall achieve a density of at least 70% of full turf to be considered acceptable as final stabilization.

2151.11 Installation of Controls: The Contractor shall obey all requirements for chemical and waste controls specified in Section 2152. Contractor shall provide all specific erosion and sediment controls required by the SWPPP in accordance with the requirements of Section 2153

and 2154. If the SWPPP calls out items or controls not included in this specification, refer to the project special provisions and plans for requirements. Controls shall be installed prior to disturbance in an area, unless otherwise indicated in the plans.

2151.12 Maintenance: The Contractor shall maintain the integrity of the temporary erosion and sediment control devices as long as they are in place and necessary. Devices not functioning properly shall be corrected or replaced. Accumulated sediments shall be removed promptly as detailed in Section 2154.

2151.13 Removal: Control measures shall be completely removed from the site when they are no longer needed, unless they are approved by the Engineer to remain in place for permanent stabilization or biodegradation (i.e. erosion control blankets).

2151.14 Inspections: The Contractor shall inspect the construction site within twenty-four hours of the end of a storm which results in precipitation of 0.5 inches or greater, during both active and inactive phases. In addition, regular inspections shall be made weekly during active phases of construction. During inactive phases (such as winter when construction activity has temporarily ceased), an inspection of the site condition shall be made no less than once every 14 days. All installed practices shall be checked for proper installation, operation, and maintenance. Locations where stormwater runoff leaves the site shall be inspected for evidence of erosion or sediment deposition. Deficiencies shall be noted in a report of the inspection and corrected within seven calendar days of the inspection.

A report of each inspection is to be made within 24 hours of the inspection and shall contain the following minimum information: inspector's name, date of inspection, observations relative to the effectiveness of the practices, actions taken or necessary to correct deficiencies, a listing of areas where construction operations have permanently or temporarily stopped, observations at stormwater discharge locations, and any other item required of an inspection by the applicable permits The inspection report shall be signed by the person performing the inspection. Site inspection reports shall be maintained onsite with the SWPPP or the SWPPP shall contain written documentation of the off-site records storage location.

2151.15 Records: The Contractor shall maintain all permit required records during the job and shall transmit all necessary records to the Engineer at the completion of the work, including all Contractor and Subcontractor certifications and site inspection records, as well as other records requested by the Engineer.

2151.16 Site Access for Inspections: The Contractor shall allow authorized representatives of federal, state, or local agencies having jurisdiction of this permit, upon presentation of proper credentials, to enter the site where construction activities are located, to obtain samples of any discharge water, to have access to and copy at reasonable times, any records which shall be kept, and to inspect any facilities or equipment.

2151.17 Maximum Areas of Disturbance at One Time: The surface area of erodible earth material exposed by site operations shall be limited by the Engineer according to the Contractor's capability and progress in keeping with the approved schedule. Existing vegetation shall be preserved or retained as long as practical and the time period for soil areas to be without permanent surface or vegetative cover shall be minimized. The maximum surface area of erodible earth exposed at one time shall not exceed ten (10) acres unless approved in writing by the Engineer or otherwise provided for in the plans. The Contractor shall pay close attention to the grading and disturbance limits indicated on the plan or authorized by the Engineer.

2151.18 Measures Where Construction has Ceased: Soil stabilizing erosion control measures as detailed in Sections 2153 shall be implemented within 14 calendar days after construction activities have temporarily or permanently ceased on any portion of the site. Exceptions to this requirement are as follows: (a) if implementation of erosion controls is precluded by snow cover, such measures shall be taken as soon as practical after snowmelt, or (b) a waiver to this requirement is justified and approved by the Engineer in writing, in which case a specific deadline for installing erosion controls shall be established.

2151.19 Duration Limits for Select Activities: For certain items of work, the plans or standard sequences may contain specific time limits for the maximum duration of exposure, typically stated as "Item A construction shall have a maximum exposure time of X days." Where such limits are specified, the time shall be measured from the date in which stabilized ground cover is first disturbed in the work area until the specified construction is complete and permanent or temporary stabilization shown on the Plans is applied. Contractor shall be responsible for documenting the elapsed time on all such work, typically by noting the time in their inspection logs, taking time-stamped photographs, and/or by marking the area with a wooden stake documenting beginning and ending dates. The Engineer may grant extensions of time requested by the Contractor when justified and suitable interim stabilization measures are provided.

2151.20 Construction near Rivers, Streams, and Waterbodies: Construction operations in or near rivers, streams, and other water impoundments shall be restricted to those areas essential for construction. Unless otherwise provided for in the plans, a minimum 50 feet buffer of undisturbed vegetation shall be maintained between construction operations and defined drainage courses. Where such buffers are not provided, work shall not be initiated until all materials and equipment necessary to complete the work are on site and such operations shall be completed as quickly as possible once the work has begun. When no longer required, all falsework, pilings, temporary crossings, and other obstructions shall be promptly removed. Stream crossings shall be limited to those detailed in the plans or as approved by the Engineer.

2151.21 Culverts, Ditches and Storm Sewers: Construction of major elements of the proposed storm sewer or other drainage systems shall be coordinated to minimize the duration of time over which stormwater would run through temporary, erodible channels. Unless otherwise indicated on the plans, construction of the major elements of this system shall be among the first activities on the project. Once begun, construction shall proceed expeditiously to completion, including placement of all final headwalls, end structures, rip-rap and other end treatments. Temporary or permanent ditches which are graded on the project shall either be stabilized or have temporary sediment controls installed within seven (7) days of their grading.

2151.22 Methods of Measurement: No separate measurements will be made for the general requirements covered by this Section.

2151.23 Basis of Payment: Compliance with the general requirements of this section will not be paid separately, but shall be subsidiary to other items listed in the contract. (Note: Some Owner's may elect to pay for Administration of erosion control requirements as a separate line item. Consult the contract and job special provisions if that is the case.

SECTION 2152 CHEMICAL AND WASTE CONTROLS

2152.1 Summary: This section describes specific requirements to control non-sediment related pollutant discharges from chemicals and wastes from the site, including requirements for chemical handling, spill prevention, spill response, and waste disposal.

2152.2 Solid, Liquid, and Hazardous Wastes: All trash shall be placed in dumpsters or trash barrels provided by the Contractor and accumulated trash shall be hauled offsite and properly disposed. Floating debris found in any waterbody on or immediately adjacent to construction shall be removed immediately, regardless of source. Hazardous wastes shall be stored, transported offsite, and disposed of properly.

2152.3 Sanitary Wastes: Sanitary facilities shall be made available and their use enforced by the Contractor.

2152.4 Leak Prevention: All equipment used onsite shall be free of leaks, receive regular preventative maintenance, and be inspected daily to reduce chance of leakage. No fueling, servicing, maintenance, or repair of equipment shall be done within 50 feet of a stream, drainage way, lake, storm sewer manhole or other water body. Onsite fuel tanks shall be in good condition, free of leaks or drips, painted brightly for visibility, and monitored daily. All fuel tanks, including mobile trailers, shall be protected by a secondary containment system or earthen berm sized to contain 110% of the full tank volume.

2152.5 Concrete Washout: Concrete wash or rinse water from concrete mixing equipment, tools and/or ready-mix trucks, tools, etc., shall not be discharged into or be allowed to run directly into any existing water body or storm inlet. One or more locations for concrete wash out shall be designated on site and installed in accordance with the Standard Drawings.

2152.6 Chemical Handling and Storage: Chemicals or materials capable of causing pollution shall only be stored onsite in their original container. Materials stored outside shall be in closed and sealed water-proof containers and located outside of drainage ways or areas subject to flooding. Manufacturer's data regarding proper use and storage, potential impacts to the environment if released, spill response, and federally-defined reportable quantities for spill reporting shall be maintained by the field superintendent onsite at all times. Locks and other means to prevent or reduce vandalism shall be used.

2152.7 Herbicides, Pesticides and Fertilizers: Herbicides, pesticides and fertilizers used as part of the work shall be applied only in accordance with manufacturer recommendations. Direct spray into water bodies is prohibited. Such chemicals shall not be used if rain is forecast within 24 hours, unless they are approved for wet weather application.

2152.8 Spill Clean-up and Management: If it is safe to do so, Contractor shall stop the source of any spills or leaks and shall contain spills immediately with an appropriate device, earthen berm, sawdust, sand, kitty litter, rags or other absorbents. Manufacturer recommendations shall be followed. Leaks from broken hoses shall be immediately contained with hose clamps, plugs, or drained into leak-proof containers. Contractor shall have the tools, equipment, and supplies necessary for spill response onsite at all times and ready for immediate use. Contractor personnel shall be trained to properly respond immediately to a leak or spill. All spills shall be cleaned up and disposed of in accordance with applicable federal, state, and local regulations. Local hazardous materials response units shall be called if assistance is needed in stopping or containing the spill.

2152.9 Spill Reporting: All spills in excess of reportable quantities shall be reported to the appropriate federal, state, and local agencies within 24 hours of their occurrence. The Contractor shall maintain a listing of all such agencies onsite within the SWPPP and in easy reference for onsite personnel. Spills that pose an immediate threat to public safety or contamination of a water body shall be reported immediately to designated first response authorities. A current listing of applicable phone numbers for the jurisdiction shall be placed at the front of the SWPPP and posted conspicuously on the jobsite.

2152.10 Methods of Measurement: No separate measurements will be made for the requirements covered by this Section.

2152.11 Basis of Payment: Compliance with the requirements of this section will not be paid separately, but shall be subsidiary to other items listed in the contract.

SECTION 2153 EROSION CONTROLS

2151.1 Referenced Standards:

The following standards are referenced directly in this section. The latest version of these standards shall be used.

APWA, Kansas City Metropolitan Chapter (KC-APWA):
Standard Drawings, Division III of Standard Specifications and Design Criteria

Erosion Control Technology Council (ECTC):
Standard Specification for Rolled Erosion Control Products (RECPs).

Kansas Department of Transportation (KDOT):
Standard Specifications for State Road & Bridge Construction, 2015 Edition or later including all latest errata and adopted Special Provisions, as well as associated Standard Drawings.

Missouri Department of Transportation (MoDOT):
Missouri Standard Specifications for Highway Construction, 2011 edition or later including all supplemental specifications, as well as associated Standard Plans.

Texas Department of Transportation (TxDOT):
Approved Products List (APL) for Erosion Control. Based on testing and standards cited in the report "TXDOT / TTI Hydraulics, Sedimentation and Erosion Control Laboratory: Field Performance Testing of Selected Erosion Control Products".

US Composting Council (USCC):
STA – Seal of Testing Assurance Program; and TMECC - Test Methods for the Examination of Composting and Compost. Information available online at www.compostingcouncil.org.

2153.2 Summary: This section describes specific requirements for installation and maintenance of temporary measures to stabilize onsite soils and prevent erosion during construction.

2153.3 Materials: Materials used for erosion controls shall meet the requirements of the following subsections. Unless otherwise specified herein, the Contractor shall submit, for each material used, a certification prepared by the manufacturer which states that the materials meet all the requirements of this specification. The manufacturer shall also provide supporting documentation and testing results to validate this certification, if requested by the Engineer. Manufacturer's instructions for installation of materials (when applicable) shall be available onsite whenever work is occurring and a copy shall be submitted to the Engineer upon request.

2153.4 Permanent Seeding and Sodding: Final stabilization with vegetation by either permanent seeding or sodding is the most effective form of erosion control and shall be achieved as early in the construction process as possible.

A. Materials, Construction Requirements and Maintenance: Permanent seeding or sodding shall be provided as specified in Section 2400 of these Standard Specifications.

Contractor shall schedule work so that permanent seeding is conducted as early as practical in the construction process. Multiple mobilizations of seeding or sodding operations shall be expected.

B. Out-of-Season Special Provision: The Engineer may request that permanent seeding be conducted anytime between April 16 and August 14 and/or that sodding be conducted anytime between June 1 and September 1, even though such dates are outside the standard seasons established in Section 2400. If agreed to by the Contractor, then the Contractor shall conduct such seeding or sodding and shall be responsible for the establishment of a vigorous and healthy seed or sod cover. The Contractor will be paid, however, for all watering necessary during the period that falls outside the standard season.

C. Measurement and Payment: Shall be as specified in Section 2400. If out-of-season seeding or sodding has been authorized, then "Out of Season Watering" will be measured by the 1,000-gallon unit applied and paid for at the contract unit price.

2153.5 Temporary Seeding: Interim stabilization with annual vegetation to provide temporary cover to minimize erosion. This item only covers seeding installed by conventional drilling.

A. Materials: Seed and equipment used for temporary seeding shall meet all the criteria given for permanent seeding in Section 2400 of these Standard Specifications. Fertilizer is not required.

Mulch used for temporary seeding shall meet the same requirements as “mulch cover” in subsection 2153.6. Mulch is required unless erosion control blankets are being used instead.

The following seed mixtures and planting rates shall be used:

1. Type "TR" Seed: This mixture will normally be used when temporary seeding is conducted between February 15 and May 31, or between September 1 and October 31. The seed mixture will be as follows:

Kind of Seed	Minimum Pure Live Seed (%)	Rate of Pure Live Seed (lbs per Acre)
Annual Rye Grass	83	90

2. Type "TM" Seed: This mixture will normally be used when temporary seeding requires heat tolerance, typically for planting anytime between May 1 and August 15. (Volunteer millet is aesthetically objectionable in turf grass lawns; therefore, some jurisdictions may restrict use of this mix. Confirm local requirements before use.) The seed mixture will be as follows:

Kind of Seed	Minimum Pure Live Seed (%)	Rate of Pure Live Seed (Lbs per Acre)
Millet	77	65

3. Type "TW" Seed: This mixture will normally be used when temporary seeding requires cold tolerance, typically for planting anytime between September 15 and November 30. The seed mixture will be as follows:

Kind of Seed	Minimum Pure Live Seed (%)	Rate of Pure Live Seed (Lbs per Acre)
Winter Wheat	83	120

B. Construction Requirements: Preparation, planting and all other construction requirements for temporary seeding shall be as specified for permanent seeding in Section 2400, except as modified herein. Temporary seeding shall be drilled (see 2153.8 for hydraulic application of temporary seed). Prior to application, the soil shall be tilled to a depth of at least 2 inches and gullies, depressions, and large clods eliminated. Roller compaction of the seedbed is not required. Within 24 hours of seeding, mulch or erosion control blankets shall be applied. When mulch is used, it shall be applied in accordance with the same requirements given for “Mulch Cover” in subsection 2153.6. When erosion control blankets are used, they shall be installed in accordance with the requirements in subsection 2153.9. The Contractor shall initially water all areas of temporary seeding at least one-quarter inch as soon as the mulch is laid. Additional watering may be necessary for plant germination and adequate growth to provide cover. Contractor shall schedule work so as to provide temporary seeding as early as practical in the construction process. Contractor shall maintain a readiness to perform temporary seeding frequently during the progress of the project. No more than 7 calendar days shall elapse between the Engineer’s request for temporary seeding and its application. Multiple mobilizations to seed areas as construction progresses shall be expected.

C. Maintenance: Mulch shall be replaced or repaired as needed during germination and early growth. Bare spots shall be patched, by hand seeding if necessary. Vehicle and personnel traffic shall be minimized in areas seeded.

D. Measurement and Payment: "Temporary Seeding" will be measured per acre or hundredth part thereof and paid for at the contract unit price. No differentiation shall be made for type of temporary seed used. Mulch and watering shall not be measured or paid for separately on any temporary seeding, but all such costs shall be subsidiary to the item. Erosion control blankets, when used, will be measured and paid separately as “Erosion Control Blanket.”

2153.6 Mulch Cover: Mulch applied without seeding to protect the soil surface from raindrop impact and reduce wind erosion and dust. Mulch Cover (without seed) is generally used when ground cover is required and temporary or permanent seeding is not feasible.

A. Materials: Mulch shall be vegetative type only, consisting of cereal straw from stalks of oats, rye, wheat or barley and shall be free of prohibited and noxious weed seeds.

B. Construction: Prior to applying mulch, the soil shall be tilled to a depth of 2 inches to eliminate hard crust and allow rainwater intercepted by mulch to infiltrate the soil. Gullies, depressions, and large clods shall be eliminated.

Mulch shall be applied at the rate of 1.5 tons/acre (3,000 lbs/acre) and be anchored into the soil a minimum depth of 3 inches by use of a heavy disc harrow, set nearly straight, or a similar approved tool. Discs of the anchoring tool shall be set approximately 9

inches apart. Anchoring shall be accomplished by not more than two passes of the tool. If approved by the Engineer, a tackifier may be applied to the mulch to anchor it instead of using the disc harrow.

C. Maintenance: Mulch cover shall be replaced or repaired as needed. Bare spots shall be filled in, by hand if necessary. Vehicle and personnel traffic shall be minimized in areas mulched.

D. Measurement and Payment: "Mulch Cover" will be measured per acre or hundredth part thereof and paid for at the contract unit price. Mulch is not measured and paid separately when laid down in conjunction with seeding operations.

2153.7 Hydrocover (Standard): Hydraulic application of a standardized mixture of fiber mulch, tackifier, and temporary seed to provide temporary cover.

A. Materials:

1. **Fiber Mulch:** Fiber mulch shall be a manufactured, pre-packaged, biodegradable material. The material supplied shall be meet the requirements of ECTC's Standard Specification for Hydraulic Erosion Control Products (HECPs) (version 2.4 dated April 2, 2014) for Type 3 products, having a functional longevity of 3 months, a maximum uninterrupted slope length of 50 feet, and applied to a slope that is flatter than 3:1. In addition, the material shall also be listed on the TxDOT Approved Products List for Erosion Control under the category "Mulches 4:1 or Flatter Slopes" and specified for use on "Clay or Tighter Soils".

2. **Tackifier:** Shall be food-grade hydrolyzed guar gum powder or alternate material as specified by the manufacturer. It shall be mixed with the cellulose fibers based on the manufacturer's recommendations.

3. **Water:** Shall be clean, potable water mixed at a rate suitable for the equipment being used and as recommended by the manufacturer.

4. **Seed:** Shall be Type TR, TM or TW seed as specified in Section 2153.5 and appropriate for the season. Seed shall be mixed to provide no less than the seeding rate per acre given in that section.

5. **Fertilizer**: Not required unless specified by the Engineer

B. Construction Requirements: The fiber mulch shall be added to the hydraulic seeder along with proportionate amounts of seed, tackifier, and water in accordance with the manufacturer's recommendation. It shall be applied to make a uniform coverage of the soil surface. Prior to application, the soil shall be tilled to a depth of at least 2 inches and smoothed to eliminate gullies, depressions, or large clods. The Standard Mix Hydrocover mix shall not be used on any slope steeper than 4:1. Contact the engineer for alternate specifications to be used on steeper slopes if there is a discrepancy.

Hydrocover shall be applied at a minimum rate of 2,000 pounds dry weight of fiber per acre (0.41 pounds per square yard), unless otherwise specified by the manufacturer. Once applied, the area shall be allowed to dry and vehicle and personnel traffic shall be

kept off the stabilized area. Water shall be applied as needed for seed germination and plant growth. The hydrocover operation shall be accomplished with hydraulic sprayers suitable for spreading and projecting the mixture and fitted with the appropriate nozzle tips. Sprayers shall be mechanically mixed or jet agitated.

Contractor shall maintain a readiness to provide hydrocover frequently during the progress of the project. No more than 7 calendar days may elapse between the Engineer's request for hydrocover and its application. Multiple mobilizations of hydrocover operations shall be expected.

C. Maintenance: Areas which are disturbed by construction shall be patched with additional application of slurry at the next available mobilization of equipment at no additional cost. Small areas of poor coverage may be stabilized through erosion control blankets, mulch for cover, straw wattle protection or other measures, at no additional cost.

D. Measurement and Payment: "Hydrocover (Standard)" will be measured per acre or hundredth part thereof and paid for at the contract unit price. No payment will be made for applications made outside the area intended for coverage.

2153.8 Hydrocover (Specialty Mix): Hydraulic application of specialized mixtures of fiber mulch, tackifiers, seed and other additives to provide temporary cover. Such specialized mixtures may provide for steeper slopes, more robust protection, longer durability, or enhanced vegetative growth, as compared to the Standard Mix.

A. Materials: When specialty mixtures are used, the particular mix design and ingredient requirements shall be given in the plans or special provisions. Such specialty mixtures may include additives for improved seed germination, mixtures of special polymer tackifiers and heavier rates of cellulose fiber or other cross-linking organic fibers to produce a more continuous cover (i.e. "Bonded Fiber Matrix"), or mixtures that contain polyacrylamides that chemically stabilize the underlying soils (i.e. "Stabilized Fiber Matrix"). Seed and additives shall conform to the requirements of standard hydrocover, except as modified in the plans, special provisions or by the manufacturer's recommendations for the specialty mix.

B. Construction and Maintenance Requirements: All construction and maintenance requirements shall be the same as for standard hydrocover, except as modified by the plans or the manufacturer's recommendation for the specialty mix. Equipment for specialty mixes shall conform to manufacturer's recommendations.

C. Measurement and Payment: "Hydrocover (Named Specialty Mix)" will be measured per acre or hundredth part thereof and paid for at the contract unit price. No payment will be made for applications made outside the area intended for coverage.

2153.9 Erosion Control Blankets (including Turf Reinforcing Mats): Blankets or mats of natural, synthetic, or composite materials that can be rolled onto bare earth and anchored in place to provide temporary or permanent cover and/or to stabilize bare earth or channels subject to overland or concentrated surface flow. This item of work includes the use of Turf Reinforcing Mats.

A. **Materials:** Erosion control blankets of the class and type specified in the contract shall be a "Rolled Erosion Control Product" as defined by the ECTC Standard Specification. Further, the material shall be listed in the current TxDOT Approved Products List for Erosion Control. Blankets are categorized by expected use and application, as follows:

Class 1: For use as Cover and Slope Protection from overland flow:
Type A: On slopes 1:3 or flatter with clay soils.
Type B: On slopes 1:3 or flatter with sandy soils.
Type C: On slopes steeper than 1:3 with clay soils.
Type D: On slopes steeper than 1:3 with sandy soils.

Class 2: For use as Flexible Channel Liner under concentrated flow:
Type E. For shear stresses below 2 lb/sq. ft.
Type F. For shear stresses below 4 lb/sq. ft.
Type G. For shear stresses below 6 lbs/sq. ft.
Type H. For shear stresses below 8 lb/ sq. ft.

Materials supplied for Type A, B, C, D, E and F blankets shall have a minimum expected longevity of 12 months, unless otherwise stated on the plans or approved by the Engineer. Materials supplied for Type G and H shall have a longevity of greater than 5 years. Materials for Type H shall be 100% synthetic. Expected longevity shall be evaluated based on the manufacturer's data.

B. **Construction Requirements:** The Contractor shall install erosion control blankets in the locations shown in the plans and in accordance with the Standard Drawings and manufacturer's recommendations.

C. **Maintenance**: Maintain blankets in accordance with the Standard Drawings and manufacturer's recommendations.

D. **Measurement and Payment:** "Erosion Control Blanket (Named Type)" will be measured per square yard of sloped surface area covered by the completed mat and paid for at the contract unit price for the given type. Excess blanket used for overlap at seams, anchoring, waste, repairs, etc. will not be included in the measurement. When blankets are used in conjunction with permanent or temporary seeding, erosion control blanket will be paid for at the contract unit price and the seeding operation shall be paid separately.

2153.10 Compost Cover: Organic compost applied with or without seeding to protect the soil surface from raindrop impact, absorb stormwater, facilitate vegetation growth and reduce wind erosion and dust.

A. **Materials:** *(Note: The material requirements in this subsection do not apply for compost filter berms and compost filter socks, and are described more fully in Sections 2154.10 and 2154.11.)*

All compost shall be mature, sanitized, well-composted organic matter free of identifiable feedstock constituents and offensive odors. Compost shall have been produced by the aerobic decomposition of organic material. Organic material sources may include leaves and yard trimmings, paper fiber, wood, bark, biosolids, food scraps, composted manures, or combinations of these products. Biosolids compost shall comply with the

Standards for Class A biosolids outlined in 40 Code of Federal Regulations (CFR) Part 503. The compost shall be free of any refuse, contaminants, and any material toxic to plant growth. Compost must not be derived from mixed municipal solid waste. Compost shall comply with all applicable state and federal regulations regarding production and distribution.

All compost material supplied shall be certified through one of the following programs:

A. The USCC STA Program through a certified supplier, and wherein all testing procedures follow the USCC TMECC manual.

B. The KDOT Specification found at Section 2105 for Soil Compost Materials, wherein all testing procedures are in accordance with the requirement listed there. Under this specification, however, compost sources from the State of Missouri are not excluded, provided that such sources are in compliance with Missouri regulations, satisfy the material and testing requirements found in the KDOT specification, and are otherwise found to be suitable by the Engineer.

Before delivering of the compost, the suppler shall provide a copy of the lab analysis and certifications as outlined for the applicable program. The supplier shall also document the feedstocks and sources used in the compost to be supplied.

B. Construction: Prior to applying compost, the soil shall be tilled to a depth of 2 inches to eliminate hard crust and allow rainwater intercepted by the compost cover to infiltrate into the soil. Gullies, depressions, and large clods shall be eliminated.

Compost shall be applied to a depth of 1.5 to 2 inches when alone or 1 to 1.5 inches when used in conjunction with seeding operations. Compost shall be uniformly applied using an approved spreader unit, which may include mechanical or pneumatic (blower) devices. Compost shall extend at least 3 feet beyond the shoulder of any slope to ensure that runoff does not flow under the cover. Once applied, the compost shall be thoroughly watered to improve settling.

C. Maintenance: Compost shall be replaced or repaired as needed. Bare spots shall be filled in, by hand if necessary. Vehicle and personnel traffic shall be minimized in areas covered.

D. Measurement and Payment: "Compost Cover" will be measured per cubic yard of compost in the vehicle at the point of delivery to the project. When compost cover is used in conjunction with permanent or temporary seeding, compost cover will be paid at the contract unit price and the seeding operation shall be paid separately. The unit price for compost cover will include any deductions for standard mulching that is no longer required.

2153.11 Surface Roughening: Any rough graded slope that is not yet ready for seeding or other treatment and which will not be disturbed by ongoing construction for a period of 7 days or more shall be roughened by grooving, tracking, disking, or ripping it with a disc, tiller, spring harrow or other suitable implement. Such grooves shall be located traverse to the slope face and shall not be less than 3 inches deep nor spaced more than 15 inches apart. The requirement to roughen slopes by tracking or grooving shall apply to all slopes steeper than 6:1

horizontal to vertical. No measurement or payment shall be made for this item, but it shall be subsidiary to the earthwork.

2153.12 Dust Control: Contractor shall take effective measures to prevent blowing dust. Adequate moisture content shall be maintained in all exposed soils by application of water or other approved dust suppressant. Areas to be subsequently paved may be treated with asphalt emulsion. When dust produced by operations such as sand blasting, concrete grinding, and sawing of concrete or masonry would create a public nuisance, they shall be performed under a water spray or an alternate construction method shall be used. No measurement or payment shall be made for this item, but it shall be subsidiary to other work.

2153.13 Method of Measurement: Erosion controls will be measured in the manner specified in each applicable subsection.

2153.14 Basis of Payment: Erosion controls will be paid for at the contract unit price specified in each applicable subsection.

SECTION 2154 SEDIMENT CONTROLS AND DIVERSIONS

2154.1 Referenced Standards:

The following standards are referenced directly in this section. The latest version of these standards shall be used.

AASHTO:
M 288 - Geotextile Specification for Highway Applications

APWA, Kansas City Metropolitan Chapter (KC-APWA):
Standard Drawings, Division III of Standard Specifications and Design Criteria

ASTM:
D 3786 - Test Method for Hydraulic Bursting Strength of Textile Fabrics – Diaphragm Bursting Strength Tester Method
D 4355 - Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus

Kansas Department of Transportation (KDOT):
Standard Specifications for State Road & Bridge Construction, 2015 Edition or later including all latest errata and adopted Special Provisions, as well as associated Standard Drawings.

Missouri Department of Transportation (MoDOT):
Missouri Standard Specifications for Highway Construction, 2011 edition or later including all supplemental specifications, as well as associated Standard Plans.

2154.2 Summary: This section describes specific requirements for installation and maintenance of temporary measures to detain, filter, or cause settlement of sediment from runoff, as well as measures used to temporarily direct or divert runoff onsite or at the site perimeter.

2154.3 Materials: Materials used for sediment controls and diversions shall meet the requirements of the following subsections. Unless otherwise specified herein, the Contractor shall submit a certification prepared by the manufacturer for each material used which states that the materials meet all the requirements of this specification. The manufacturer shall also provide supporting documentation and testing results to validate this certification, if requested by the Engineer. Manufacturer's instructions for installation of materials (when applicable) will be available onsite whenever work is occurring and a copy shall be submitted to the Engineer upon request.

2154.4 Sediment Removal and Disposal: Removal of accumulated, settled sediment from behind barriers, traps, or within basins.

A. Materials: Not applicable.

B. Construction Requirements: Accumulated sediment shall be removed when it exceeds the volumes specified for any particular measure or would otherwise impede the proper operation of control measures. Sediments removed shall be mixed with other onsite materials and incorporated into project fills, spread loosely across the site, or

hauled offsite as necessary. Sediments shall not form an identifiable layer or seam in any fill. Sediments hauled offsite shall be dewatered first or hauled in a water tight truck. Sediments shall be located and compacted in a way which minimizes the likelihood of being resuspended in future rainfalls. Removal shall be by machine or hand work, whichever is most feasible.

C. Maintenance: Not applicable.

D. Measurement and Payment: Sediment removal is not measured or paid separately, but shall be subsidiary the other items in the contract. The proper and timely use of erosion controls will help reduce the quantity of sediment that must otherwise be cleaned out of downstream controls.

2154.5 Silt Fence: A temporary barrier of synthetic fabric embedded in the ground and supported by posts used to divert water or to maintain a trap for settlement.

A. Materials, Construction Requirements and Maintenance: Refer to the Standard Drawings.

B. Measurement and Payment: Silt fence will be measured by the linear foot and will be paid for at the contract unit price for "Silt Fence" Initial excavation of depressions on the upstream side of silt fence to create added storage shall be subsidiary.

2154.6 Straw Bales: Straw bales shall not be used.

2154.7 Rock Ditch Checks: Small temporary stone ditch checks used to form protect ditches with larger flows.

A. Materials: Rock shall be a clean aggregate free of deleterious substances, including earth, chert, cracks, seams, soapstone, shale or other easily disintegrated materials. Rock shall come from a primary run and be screened to remove the easily separated fines. It shall meet the gradation requirements below for the nominal size specified:

2-inch Rock: Fifty percent (50%) by weight of the particles shall be larger than 1.5 inches in diameter and none shall be larger than 4 inches. Total aggregate and fines smaller than ½ inch shall not exceed 2 % by weight.

4-inch Rock: Fifty percent (50%) by weight of the particles shall be larger than 4 inches in diameter and none shall be larger than 9 inches. Total aggregate and fines smaller than 1" shall not exceed 2 % by weight.

6-inch Rock: Fifty percent (50%) by weight of the particles shall be larger than 6 inches in diameter and none shall be larger than 12 inches. Total aggregate and fines smaller than 1" shall not exceed 2 % by weight.

The Engineer may approve modifications to these gradations to accommodate readily available stockpiles from local quarries.

B. Construction Requirements: See Standard Drawings.

C. Maintenance: See Standard Drawings.

D. Measurement and Payment: "Rock Ditch Checks (Named Rock Size)" will be measured per ton or tenth part thereof, as placed, and paid for at the contract unit price for the nominal size of rock indicated. Initial excavation of depressions on the upstream side of rock barriers to create added storage shall be subsidiary.

2154.8 Synthetic Sediment Barriers (Type): Any one of various proprietary ditch checks, primarily composed of synthetic materials, that can be used instead of the other measures specified herein to control velocities and erosion in ditches or swales.

A. Materials: Materials for any given Type of Synthetic Sediment Barrier shall be as called out in the plans or Standard Drawings. In addition, this category may also include those measures called out as “Synthetic Sediment Barrier” in KDOT Specification Sections 902 and 2114 or those called out as “Alternate Ditch Checks” in MoDOT Specification 806.

B. Construction Requirements: Install Synthetic Sediment Barrier’s in accordance with manufacturer instructions. Pay particular attention to anchoring, protection of channel underneath, and to conditions at the ends to avoid bypassing.

C. Maintenance: Remove silt when it accumulates to 20% of the height of the barrier or when the accumulation prevents the proper operation of the ditch check, whichever is less. If units are damaged or dislodged during the sediment removal process, repair and re-establish continuity.

D. Measurement and Payment: "Synthetic Sediment Barriers (Type) " will be measured per linear foot and paid for at the contract unit price. Underlying erosion control blanket or geotextiles shall be subsidiary. If no specific type is given, then all such measures allowed for the job will be paid for at a uniform price.

2154.9 Biodegradable Logs (or Wattles): Circular tubes of netting filled with straw or other biodegradable fibers and used as a small height barrier for diversion of water or settlement.

A. Materials: Biodegradable logs are manufactured using a variety of filler materials. For this specification, the following two classes of filler are specified:

Class A: Rice or wheat straw fibers Fiber material shall be certified as weed free in accordance with state standards. Fibers shall have an average length greater than 3 inches. Type A wattles shall have a durability in the field of no less than 3 months. Type A wattles shall be specified with dimensions and minimum weights of 9-inch diameter (1.7 lbs./lin ft.); 12-inch diameter (2.5 lbs/lin. ft.) or 20-inch diameter (3.5 lbs/lin. Ft.)

Class B: Excelsior wood fibers, coconut fiber (i.e. coir), jute, or other longer-lasting biodegradable materials. Such materials shall be free of deleterious substances, compacted tightly, and shown to have an in-field durability of 6-months or greater. Class B wattles shall be specified with dimensions 9-inch diameter, 12-inch diameter, or 20-inch diameter.

Containment netting shall be jute or light-weight plastic. The entire wattle unit shall be sufficiently durable to withstand weather, construction, and installation conditions for no less than the life of the filler material (see above), including multiple movements and

reinstallations. Wood posts of sufficient strength withstand installation and weather shall be used for anchoring.

B. Construction Requirements: Biodegradable logs shall be located as shown on the plans or directed by the Engineer. Individual units shall be installed in accordance with manufacturer's recommendations and the Standard Drawings.

C. Maintenance: Maintain as called out in the Standard Drawings.

D. Measurement and Payment: "Biodegradable Logs (Size and Class)" will be measured per linear foot and paid for at the contract unit price. When used without other qualifier, the phrase "Straw Wattle" shall be considered equivalent to a 9-inch Class A Biodegradable Log.

2154.10 Compost Filter Berm: A berm or dike of compost placed to trap pollutants and filter runoff from small areas of overland flow.

A. Materials: Compost to be used in filter berms shall meet the following requirements:

Parameter	Range
pH	5.0-8.5
Moisture Content	<60%
Organic Matter Content	>25% of dry weight
Particle Size	99% < 2", 30%-50% < 3/8"

B. Construction Requirements: Compost filter berms shall be constructed using specially designed pneumatic equipment (blowers) and a berm shaping device, or other equipment as approved by the Engineer. If a blower is used, compost shall be blown directly at the soil surface to help settle, compact and shape the berm. The berm shall be formed in a trapezoidal shape, having a typical dimension of 3 feet wide at the base and 1.5 feet high. Position the berm around designated soil areas and parallel to the contour. The ends of the berm shall be pointed up slope such that the bottom elevation at each end is higher than the top elevation throughout most of the slope, so as to prevent water from flowing around the end of the berms.

C. Maintenance: Berms shall be reshaped and compost added as necessary to maintain their function and dimensions. Breaches in the berm shall be repaired promptly. Compost may be added by hand and tamped in place. Unless otherwise directed by the final landscape plans or by the Engineer, removal of the compost berm shall be made by spreading the compost in a thin layer over adjacent planted areas.

D. Measurement and Payment: "Compost Filter Berm" will be measured per linear foot and paid for at the contract unit price.

2154.11 Compost Filter Sock: A compost filter encased in a geotextile tube that serves a similar purpose to compost filter berms, particularly in areas with more concentrated overland runoff.

A. Materials: Compost to be used in filter socks shall meet the respective requirements for compost specified in Section 2154.10 for Filter Berms.

Tubes used for compost filter socks shall be produced from a 5 mil thick continuous HDPE or polypropylene filament, woven into a tubular mesh netting material, with openings in the knitted mesh 1/8 in (3 mm) to 3/8 in (10 mm). Tubes shall have a diameter of either 8, 12, or 18 inches, as specified. The 12-inch tubes are for general use, the 8-inch tubes are typically for flat slopes, and the 18 inch tubes are typically for steep slope protection and minor check dams.

Stakes for securing filter socks shall be hardwood with a 2” by 2” nominal dimension. Steel or other non-biodegradable stakes shall not be used.

B. Construction Requirements: Compost filter socks shall be constructed on site or delivered to the jobsite. When assembled on site, the sock shall be filled using a pneumatic blower. The sock shall be formed continuously for the length needed, up to 200 feet long. When multiple socks are needed, the end of one sock shall be pulled over the second to create a “sleeved” overlap. Once overlapped, the second section is filled with compost to create a seamless unit. Once placed, the filter sock will settle into an oval shape. Trenching is not required. Existing soil in the vicinity of the filter sock shall remain undisturbed to the extent practical. The sock shall be anchored by driving stakes through the center of the filter sock at 10 foot intervals, at all sleeved overlaps, and at each end. Where an adjustable section of filter sock is necessary (such as to permit dry weather vehicle access), the stakes may be placed on the downhill side of the sock rather than through it. Filter socks may be seeded.

C. Maintenance: Compost filter socks shall be inspected to ensure the sock material is intact and to determine if runoff is bypassing or undermining the units. Additional filter socks may be stacked as needed. Breaches in the line shall be repaired promptly. Unless otherwise directed by the final landscape plans or by the Engineer, removal of the compost sock shall be made by spreading the compost in a thin layer over adjacent planted areas. The HDPE or polypropylene sock shall be sliced open longitudinally to release the compost and the sock disposed of.

D. Measurement and Payment: "Compost Filter Sock (Named Diameter)" will be measured per linear foot and paid for at the contract unit price for the nominal diameter indicated.

2154.12 Diversion Berms: Earthen berms temporarily graded and compacted to provide a diversion of overland flow. Can be used in conjunction with slope drains at the top of slopes to prevent sheet flow down the slope face.

A. Materials, Construction and Maintenance: Refer to the Standard Drawings.

B. Measurement and Payment: "Diversion Berms" will be measured per linear foot and paid for at the contract unit price. Such payment shall be full compensation for berm installation, maintenance, removal and any other work noted on the plans.

2154.13 Slope Drain: A flexible tubing or conduit used to convey concentrated water from the top of a slope down to the toe and thereby preventing erosion over the slope face.

A. Materials, Construction and Maintenance: Refer to the Standard Drawings.

B. Measurement and Payment: "Temporary Slope Drain" will be measured per linear foot and paid for at the contract unit price. Such payment shall include installation of outlet protection.

2154.14 Inlet Protection: Any one of a variety of devices or procedures used to allow water to enter an stormwater inlet while filtering or temporarily impeding the flow sufficiently to reduce the quantity of sediment carried.

A. Materials: When used, biodegradable logs, compost filter socks, synthetic sediment barriers, silt fence, or rock ditch checks shall meet the material requirements given by other items of this specification. All other material specifications are as shown in the Standard Details or on the plans. Straw wattles are not allowed for curb inlet protection. Unless otherwise restricted in the plans, the Contractor may also use any applicable inlet protection system allowed by KDOT Specification 902 and 2114 and the Standard Drawings or pre-approved materials list under the category “Temporary Inlet Sediment Barriers (if in Kansas); or any applicable inlet protection system allowed by MoDOT Specification 806 and Standard Plans under the category “Inlet Checks” (if in Missouri).

B. Construction Requirements: Use the inlet protection systems shown on the plan, as appropriate. Provide the given system in accordance with the Standard Drawings. Alternate inlet protection methods may be approved or specified by the Engineer. The appropriate details for a given inlet will change during the progress of the job and adjustments shall be made as inlet construction progresses. Each inlet shall be protected continuously from initial construction until final stabilization. The ultimate test of acceptability is performance in preventing the migration of sediments through the inlet.

When surrounding conditions are such that protection of the inlet would lead to an increased risk of flooding of adjacent structures or produce a hazard to motorists, the barriers shall be adjusted or eliminated to avoid such impacts. In those cases, extra attention shall be paid to minimize the degree of sediment carried in the flow that reaches the inlet.

The general cases of inlet protection and the performance expected from each are as follows:

1. All Inlets at Sump Conditions: Inlets at sump conditions shall remain accessible for flow at all times. Small barriers, depressions and/or filters are used to screen larger sediments and initiate settlement of the water prior to it entering the inlet by creating a ponding zone. Generally, stormwater will enter the inlet via weir flow over the top of the barrier. Such water is generally the least-sediment laden as it is decanted from the top of the ponded area.

2. Street Inlets on Grade: On-grade inlet shall be converted into a localized sump condition by installing a barrier downstream and around the inlet of sufficient height to produce ponding and prevent bypass, while a barrier, depression, and/or filter in front of the inlet induces settlement of solids. Bypassing of water

at the on-grade inlet shall not be allowed and the inlet shall remain open to accept flow without causing excessive flooding.

3. Selected Inlets Closed to Flow: In select locations, the plans may designate certain inlets as “closed to flow.” In those situations, the objective is to provide sufficient blockage of permanent and temporary openings to prevent entry of stormwater into the inlet. Such locations will be clearly indicated on the plans, and the closed condition for flow may be designated for only a portion of the construction period. The Contractor shall notify the Engineer if they believe that the closure of such inlets would result in an increased risk of flooding or downstream erosion, and such concerns shall be resolved before closing an inlet to flow.

C. Maintenance: Sediment shall be removed from each inlet after every rainfall event that exceeds 1/2" or which results in a visible accumulation of sediment. Particular attention shall be paid to prevent blockage of inlets or cases where resuspension of captured sediment is likely. Specific maintenance issues unique to each inlet protection type shall be addressed as outlined in the Standard Drawings.

D. Measurement and Payment: “Inlet Protection” will be measured per each inlet protected and paid for at the contract unit price. Each inlet will be measured only one time for the duration of the project regardless of the number of phases or protection methods used to protect a single inlet. Unless otherwise specified in the plans or contract documents, inlet protection at all locations will be paid at the same unit price.

2154.15 Construction Entrance: A stabilized layer of large aggregate and other features, located in areas of high traffic and at the construction entrance and exit, intended to remove mud and silt embedded in tires, to prevent tracking sediments off the site.

A. Materials, Construction and Maintenance: See Standard Drawings.

D. Measurement and Payment: "Construction Entrance" will be measured by the square yard and paid for at the contract unit price. All other features required for the entrance shall be subsidiary.

2154.16 Sediment Trap: A temporary reservoir and embankment with a stone outlet that is constructed across a drainage way to intercept sediment-laden runoff and provide retention time sufficient to settle out a majority of solids. Used for smaller watersheds where the engineered outlet works of a sediment basin are not required.

A. Materials: See Standard Drawings.

B. Construction Requirements: See Standard Drawings. The construction of the sediment trap shall be carried out in a manner such that it does not result in sediment problems downstream. The embankment of the sediment trap shall be stabilized with temporary or permanent vegetation immediately after installation.

C. Maintenance: See Standard Drawings.

D. Measurement and Payment: "Sediment Traps" shall be measured per each trap constructed and paid for at the contract unit price. Unless otherwise specified in the plans or contract documents, each trap shall be paid for at the same unit price.

2154.17 Sediment Basin: A temporary reservoir and embankment with engineered outlet works that is constructed across a drainageway to intercept sediment-laden runoff from large areas and provide retention time sufficient to settle out a majority of solids.

A. Materials: See Standard Drawings.

B. Construction Requirements: See Standard Drawings. Where the plans indicate that a temporary sediment basin is to be converted into a permanent basin, pond, or other stormwater facility, the construction, use, and removal or alterations shall be coordinated to result in a final facility that is operational in the time frame specified in the plans and which causes a minimum amount of disruption to the sitework, downstream channel, or future facility and minimizes the amount of rework needed. The construction of the sediment basin shall be carried out in a manner such that it does not result in sediment problems downstream. The embankment and emergency spillway of the sediment basin shall be stabilized with temporary or permanent vegetation immediately after installation of the basin.

C. Maintenance: See Standard Drawings.

D. Measurement and Payment: "Sediment Basin" shall be lump sum, and no measurement for payment of any item will be made. If multiple basins are used on a project, then this item shall be lump sum for all basins collectively, unless the bidding list designates individual locations.

Eighty percent (80%) of the lump sum payment shall be made once the basin is complete, in-place and operational. The final twenty percent (20%) shall be made when the basin is removed. Such payment shall be full compensation for clearing, grubbing, grading, spillway installation, stabilization, maintenance, removal, and any other work noted on the plans, including installation of outlet protection. Routine removal of sediment shall be subsidiary

If the basin indicated on the plans is to be converted at the end of construction into a permanent pond, basin, or other stormwater facility, then this item shall include payment only for the incremental costs associated with its use as a temporary basin. Permanent embankments, excavations, spillways, or other appurtenances that are constructed will be handled by the other appropriate items of the Contract for the permanent facility.

2154.18 Temporary Stream Crossings: A temporary culvert constructed in a creek, river, or stream to allow construction access and crossing.

A. Materials: See Standard Drawings.

B. Construction Requirements: See Standard Drawings. Culvert sizing, number, and orientation shall be as dictated in the plans. Care shall be taken to ensure that the stream crossing does not cause inadvertent flooding of adjacent homes, buildings, or other structures. Concerns about adequacy of culvert sizing shall be brought to the

immediate attention of the Engineer and no installation made until such concerns are resolved.

C. Maintenance: See Standard Drawings.

D. Measurement and Payment: "Temporary Stream Crossing" shall be lump sum and such payment shall be full compensation for installation, maintenance, removal and any other work noted on the plans. If multiple crossings are used on a project, then this item shall be lump sum for all crossings collectively, unless the bidding list designates locations individually.

Eighty percent (80%) of the lump sum payment shall be made once the crossing is complete, in-place and operational. The final twenty percent (20%) shall be made when the crossing is removed.

2154.19 Diversion Channels: A temporary channel excavated and stabilized to divert flow from a stream around a culvert or other in-stream structure being constructed, so as to avoid excessive erosion in the construction zone.

A. Materials: See Standard Drawings.

B. Construction Requirements: See Standard Drawings. Diversions of streams shall only be allowed if covered by the plans and approved permits for the project. Such construction, stabilization, and restoration will conform the plans and Standard Drawings. Concerns about adequacy of culvert sizing shall be brought to the immediate attention of the Engineer and no installation made until such concerns are resolved.

C. Maintenance: See Standard Drawings.

D. Measurement and Payment: "Diversion Channels" shall be lump sum and such payment shall be full compensation for installation, maintenance, removal and any other work noted on the plans. If multiple crossings are used on a project, then this item shall be lump sum for all diversions collectively, unless the bidding list designates locations individually.

Eighty percent (80%) of the lump sum payment shall be made once the diversion is complete, in-place and operational. The final twenty percent (20%) shall be made when the crossing is removed.

2154.20 Turbidity Curtains: Floating barriers of synthetic fabric curtain suspended in the water and held in a vertical position, used in lakes and perennial rivers to slow, contain or direct the flow from disturbed areas allowing solids to settle out before spreading into the surrounding water.

A. Materials: All components shall conform to the requirements given for the specific turbidity curtain system specified in the plans.

B. Construction Requirements: Shall conform to the manufacturer's recommendations for the curtain system specified in the plans, plus such additional requirements as may be listed in the plans. A manufacturer's representative shall be onsite during installation of the system.

C. **Maintenance:** Anchor lines shall be kept secure and properly positioned. Fabric, cable, and other appurtenances shall be repaired immediately as needed and in accordance with manufacturer's instructions.

D. **Measurement and Payment:** "Turbidity Curtain" will be measured by the linear foot and paid for at the contract unit price.

2154.21 Dewatering Filter: A device for filtering sediments from water that is discharged during pumping or dewatering activities.

A. **Materials:** Dewatering filters shall be constructed of materials as shown on the Standard Plans. Proprietary devices that provide equal or better performance than filters in the Standard Plans may be approved by the Engineer.

B. **Construction Requirements**: Dewatering filters shall be used whenever sediment-laden effluent is discharged from pumps used during construction for dewatering or other activities. For proprietary devices, the manufacturer's recommendations shall be followed.

C. **Maintenance:** Filters shall be cleaned or replaced as necessary to maintain filtration capacity.

D. **Measurement and Payment:** No measurement or payment will be made for "Dewatering Filters," but the use of such devices shall be subsidiary to the dewatering activity or other items of the contract. Removal of sediments from dewatering devices shall also be subsidiary.

2154.22 Method of Measurement: Sediment controls and diversions will be measured in the manner specified in each applicable subsection.

2154.23 Basis of Payment: Sediment controls and diversions will be paid for as specified in each applicable subsection.

SECTION 2155 SCHEDULING AND STANDARD SEQUENCES

It is intended that future editions of this specification will contain guidelines and requirements for scheduling and standard sequences of work in order to minimize the duration of exposure and potential for sediment discharge. This section has been reserved for that purpose.

SECTION 2156 MEASUREMENTS AND PAYMENTS

2156.1 Summary: This section includes the method of measurement and the basis of payment, for furnishing all labor, equipment, tools and materials and for the performance of all related work necessary to complete any work covered in Section 2150. Unless otherwise indicated, the maintenance, repair, removal and disposal of all temporary measures shall be subsidiary to the initial installation.

2156.2 General: Unless specifically altered by the Contract Special Provisions, the methods of measurement and payment shall be as specified in each section herein, and as listed in the Proposal.

2156.3 Measurement: The Engineer or his representative will measure the work for payment. The method of measurement and computations used in determination of quantities of work performed will be those methods generally recognized as conforming to good engineering practice.

2156.4 Items not listed in the Proposal: There shall be no measurement or separate payment for any item of work not specifically identified and listed in the Proposal and all costs pertaining thereto shall be included in the contract unit prices for other items which are listed in the Proposal.

2156.5 Measurement and Payment Summary Table

Item Description	Ref. Section	Method of Measurement	Basis of Payment
General Requirements	2151	No measurement	Subsidiary to other items
Chemical and Waste Controls	2152	No measurement	Subsidiary to other items
Permanent Seeding or Sodding	2153.4	See Section 2400	See Section 2400
Out of Season Watering	2153.4	1,000 gallon unit	Unit Bid Price
Temporary Seeding	2153.5	0.01 acre	Unit Bid Price
Mulch Cover	2153.6	0.01 acre	Unit Bid Price
Hydrocover (Standard)	2153.7	1.0 lbs dry-weight of fiber	Unit Bid Price
Hydrocover (Named Specialty Mix)	2153.8	1.0 lbs dry-weight of fiber	Unit Bid Price
Erosion Control Blanket (Named Type)	2153.9	1.0 sq. yd.	Unit Bid Price
Compost Cover	2153.10	1.0 cu. yd.	Unit Bid Price
Surface Roughening	2153.11	No measurement	Subsidiary to earthwork items
Dust Control	2153.12	No measurement	Subsidiary to other items
Sediment Removal	2154.4	No measurement	Subsidiary to other items
Silt Fence	2154.5	1.0 lin. ft.	Unit Bid Price
Rock Barrier (Named Size)	2154.7	0.1 ton	Unit Bid Price
Open-Flow Ditch Check (Type)	2154.8	1.0 lin. ft.	Unit Bid Price
Biodegradable Logs (Size and Class)	2154.9	1.0 lin. ft.	Unit Bid Price
Compost Filter Berm	2154.10	1.0 lin. ft.	Unit Bid Price
Compost Filter Sock (Named Diameter)	2154.11	1.0 lin. ft.	Unit Bid Price
Diversion Berm	2154.12	1.0 lin. ft.	Unit Bid Price
Slope Drain	2154.13	1.0 lin. ft.	Unit Bid Price

Measurement and Payment Summary Table (continued)

Item Description	Ref. Section	Method of Measurement	Basis of Payment
Inlet Protection	2154.14	Each inlet	Unit Bid Price
Construction Entrance	2154.15	1.0 sq. yd.	Unit Bid Price
Sediment Trap	2154.16	Each trap	Unit Bid Price
Sediment Basin	2154.17	No measurement	Lump Sum
Temporary Stream Crossing	2154.18	No measurement	Lump Sum
Diversion Channels	2154.19	No measurement	Lump Sum
Turbidity Curtain	2154.20	1.0 lin. ft.	Unit Bid Price
Dewatering Filter	2154.21	No measurement	Subsidiary to other items

SECTION 2200 - PAVING

CITY OF LEE'S SUMMIT, MISSOURI
STANDARD SPECIFICATIONS

The City of Lee's Summit hereby adopts Section 2200 of the Kansas City Metropolitan Chapter of APWA Construction and Material Specifications, current edition. The following additions, deletions and/or revisions are adopted as a part of Section 2200 for use within Lee's Summit. Text in bold italics indicates revisions or additions to the APWA standard.

2201 SUBGRADE PREPARATION:

2101.3.B Definitions – Subgrade Preparation: REMOVE and REPLACE with following:

Subgrade Preparation: Subgrade preparation is the repeated operation of fine-grading, ***scarification, moisture conditioning,*** and compacting the subgrade until the specified lines, grades, and cross-section, as indicated on the Plans are obtained and the materials are compacted to the specified depth and density.

2201.4.E Roll Testing of compacted Subgrade: ADD the following paragraph:

Roll testing shall be conducted on the finished layer of improved subgrade. Chemical stabilized subgrade shall be roll tested in accordance with Section 2202.7.G.1 or 7.G.2, whichever is applicable. Subgrade mechanically stabilized with geogrid or woven geotextile overlaid by aggregate base shall be roll tested on the finished aggregate base layer instead of the unimproved subgrade soils. Areas failing roll testing will be reworked and retested.

The City will have the final authority in approving or failing roll testing. The Contractor/Developer shall retain a qualified testing lab as described in Section 1000, Appendix B at no cost to the City.

2201.4 Subgrade Construction: ADD the following

F. Quality Control Testing:

TEST	***FREQUENCY***
Density/Moisture Curve	***1 per material Type***
Gradation	***1 per material Type***
Plasticity Index	***1 per material Type***
In-Place Moisture Density	***1 per 500 square yards of subgrade Minimum, 4 per day***
Roll testing	***Per Section 2201.4.E above***

2202.1 Scope: ADD the following:

Subgrade stabilization material shall be one of the following, as indicated on the plans.

A. Chemical Stabilization with either Portland Cement, hydrated lime, quicklime or Lime Kiln Dust (LKD).

B. Mechanical Stabilization will use Biaxial Geogrid, Triangular Geogrid, or Woven Polypropylene Geotextiles for roadway construction that are listed in the current Lee's Summit Public Works Approved Products List.

2202.3.A Materials: DELETE fly ash as an approved material for chemical stabilization:

2202.3 Materials: ADD the following:

E. Lime Kiln Dust is an approved material for chemical soil stabilization.

F. Portland Cement is an approved material for chemical soil stabilization.

G. Biaxial Geogrid, Triangular Geogrid, or Woven Geotextiles for Roadway Reconstruction listed in the current Lee's Summit Public Works Approved products list are approved materials for mechanical stabilization of subgrade. Geogrid shall be installed in accordance with the manufacturer's instructions.

2202.5 Thickness MODIFY as follows:

Minimum thickness for compacted soil mixture shall be 9 inches.

2202.7 Subgrade Stabilization: ADD the following

F. Quality Control Testing:

TEST	***FREQUENCY***
Density/Moisture Curve	***1 per material Type***
Gradation	***1 per material Type***
Plasticity Index	***1 per material Type***
In-Place Moisture Density	***1 per 750 square yards of subgrade Minimum, 2 per day***
Roll testing	***Per Section 2201.4.E above***

2203 UNTREATED COMPACTED AGGREGATE

2203.3.A. Materials: ADD the following sentence at the end.

MoDOT Type 5, MoDOT Type 1 or KDOT AB-3 aggregates for aggregate base

construction may be used for untreated aggregate layer in lieu of the material specified in this paragraph.

2203.4.A.7. Untreated Compacted Aggregate Construction: ADD the following

7. Quality Control Testing:

TEST	***FREQUENCY***
Density/Moisture Curve	***1 per material Type***
Gradation	***1 per material Type***
Plasticity Index	***1 per material Type***
In-Place Moisture Density	***1 per 750 square yards of agg. base Minimum, 4 per day***
Roll testing	***Per Section 2201.4.E above***

Testing shall be performed by a qualified testing lab hired by the Contractor.

Any work by Contractor prior to test submittals and subsequent City's review and approval shall be work done at the Contractor's risk.

Test reports shall be submitted to the City daily. The reports shall clearly indicate the location of all tests by street name, station and/or lot number, type of subgrade material, and subgrade elevation of test. The reports shall include the results of all tests (pass or fail) and all re-tests.

2203 DRAINABLE BASE COURSE:

2203.4.C Plant Mix Bituminous Drainable Base Course: ADD the following:

6. and handle, place and compact materials in accordance with the following.

a. Contamination of the finished base material that affects the drainage capability of the product shall not be permitted. Any areas determined to be contaminated shall be completely removed without disturbing the adjacent or underlying material and replaced at contractor's expense.

b. Rutting or other displacement of the permeable base or the underlying base will not be permitted. If displacement occurs, the material shall be completely removed without disturbing the adjacent or underlying material and shall be replaced at the contractor's expense.

c. A minimum of three passes of a 5 to 10 ton steel wheel roller shall be made, compacting the material until no further displacement is noted. Compaction shall begin as soon after spreading the mixture as the mixture is able to bear the weight of the roller without undue displacement and shall be completed before the

temperature of the mixture drops below 100 F. The compacted thickness of a single lift shall be a maximum of 4 inches.

2205 ASPHALTIC CONCRETE SURFACE AND BASE
2205.3 Referenced Standards: ADD the following
KCMMB Asphalt Material Specification

2205.3 Materials: DELETE and REPLACE with the following.
All asphalt materials shall conform to the KCMMB ASPHALT MATERIAL SPECIFICATION, current edition.

2205.4 Mixing and Proportioning: DELETE and REPLACE with the following.
All asphalt materials shall conform to the KCMMB ASPHALT MATERIAL SPECIFICATION, current edition.

2208.3.A Materials-Concrete: DELETE Paragraphs 1-4, and REPLACE with the following.

All concrete materials for paving curb and gutter, sidewalks, paths, commercial driveways and other pavements in the right of way shall conform to the KCMMB specifications. Note that KCMMB, although recommended, is not required for residential driveways.

2208.3.B Materials-Reinforcement: DELETE Paragraphs 1 and REPLACE with the following.

Bars: All bars shall be Epoxy coated and shall conform to ASTM A775.

2208.4.D.3 ADD the following

3. Longitudinal joints: Generally, longitudinal joint spacing should have the same spacing as the transverse joint spacing. The ratio between transverse and longitudinal joint spacing should not exceed 1.25. If monolithic curb is used, the width of the curb and gutter is included in the panel width along longitudinal joints. Maximum longitudinal spacing is shown in Table below:

Thickness of PCC	***Max. Longitudinal joint spacing***
6 inches	***12 feet***
7 inches	***14 feet***
8 inches	***14 feet***
9 inches	***15 feet***

2209 CURBING

2209.4.D Construction Details: Revise paragraph D to read as follows:

D. Curb Machine: ***A slip-form curb machine shall be used to place any section of curb greater than 100 feet in length.*** The machine must be equipped with mechanical internal vibrators and capable of placing curb to the correct cross section, line and grade within the allowable tolerances.

2209.4.E.2 Contraction Joints: Delete the first sentence of paragraph 2. and replace with the following:

Curbing for asphalt pavements shall have contraction joints at intervals of not more than 10 feet. They shall extend through the entire curb section from the top of the curb to a depth 2 inches below pavement surface

Curbing for concrete pavements shall have contraction joints aligned with transverse pavement joints, but no greater than 15-foot intervals.

2211 SMOOTHNESS

2211.4 Construction: DELETE and replace with the following

A. Arterials and Collectors:

1. ***Pavement smoothness on major arterial, minor arterial, and collector streets will be measured at the Contractor's expense by a 25-foot California profilograph using a 0.2 inch blanking band. Run one trace three feet from the longitudinal joint between the lanes, and another three feet from the shoulder or curb edge of the lane (five feet from the back of curb). The profilograph and testing shall be performed by a trained and certified operator. A copy of the operator's profilograph certification shall be submitted to the City prior to testing. The Contractor shall provide the Engineer with the profilogram and its evaluation within two days after paving has been completed.***

2. ***All pavements will be corrected at the Contractor's expense to less than 15 inches per mile. Pavement sections with a horizontal curve radius of less than 300 feet and/or***

vertical curves or transition areas with K values less than 30 will be excluded from the profilograph specification. Bumps greater than 0.25 inches in 25 feet shall be corrected to a bump height of less than 0.25 inches.

3. ***For asphalt pavements, the profilograph shall be run on the top of the base course. Grinding and corrections shall be made on the base course before placing the final surface course.***

B. Local and Access Roads:

1. ***Finished pavements on local roads, access roads and other areas exempted from profilographing shall be checked with a 10 foot straightedge placed parallel to the center line at any location within a driving lane. Areas showing high spots of more than 1/4 of an inch in 10 feet shall be marked and ground down with approved grinding equipment to an elevation where the area or spot will not show surface deviations in excess of 1/8 inch when tested with a 10 foot straight edge.***

2. ***For asphalt pavements, the straight-edge smoothness shall be measured on the top of the base course. Grinding and corrections shall be made on the base course before placing the final surface course.***

C. Corrections.

1. ***Smoothness corrections shall be made by diamond grinding. Grinding will be performed on the full width of the lane failing to meet the smoothness criteria. The cost of correcting the smoothness and associated traffic control shall be at Contractor's expense.***

D. Final Report:

The Contractor shall submit a final report to the Engineer with final profilograph results or straightedge measurements verifying compliance with the specified pavement smoothness requirements.

E. Measurement and Payment:

There is no measurement or payment for smoothness. These items shall be subsidiary to other pay items. There are no pay adjustments (incentive or disincentive) shall be made to the smoothness or pavement items based on the results of the profilograph testing.

SECTION 2200 - PAVING

APPENDIX for CHEMICAL STABILIZATION OF SOIL

Using CEMENT or LIME KILN DUST

1.01 DESCRIPTION

1.01.1 This work shall consist of the addition of Portland Cement or Lime Kiln Dust, mixing the material, compacting to the required density, and weatherproofing to develop a stabilized subgrade section. This item applies to natural ground or fills and shall be constructed as specified herein and in conformity with the typical sections, lines and grades as shown on the plans or as established by the Engineer.

1.02 MATERIALS

1.02.1 **Cement**: Portland Cement, or Blended Hydraulic Cement, shall comply with the physical requirements of ASTM C-150, ASTM C-595, or ASTM C-1157

1.02.2 **By-Product Lime (non-hydrated) / Lime Kiln Dust (LKD):** LKD shall meet the following Criteria

Property	
Total Calcium and Magnesium Oxides	60% minimum
Available calcium hydroxide (rapid sugar test, ASTM C 25) plus total MgO content calculated to be equivalent Ca (OH)2	30% minimum
Free moisture (as-received basis)	4% Max.
As-received loss on ignition (carbon dioxide plus moisture, combined and free)	40% Max.

Sieve Size	**Max. % Retained**
#4 (4.75 mm)	5
#30 (600 µm)	10
#100 (150 µm)	25

1.03 WATER

1.03.1 The water use in the stabilized mixture shall be clean, clear, and free of sewage, vegetable matter, oil, acid and alkali. Water known to be potable may be used without testing. All other sources shall be tested in accordance with ASSHTO T26 and approved by the Engineer.

1.03.2 **SOIL**. The soil for this work shall consist of materials on the site or selected materials from other sources and shall be uniform in quality and gradation, and shall be approved

by the Engineer. The soil shall be free of roots, sod, weeds, and stones larger than 2-1/2 inches. Asphaltic concrete or aggregate may be added to the soil during the mixing operation, provided the material can be pulverized and incorporated by the mixing equipment to meet such that 100% of the mixture passes a 1-inch sieve (No. 25) and at least 60% passes a No. 4 Sieve (4.75mm).

1.04 COMPOSITION

1.04.1 **Cement**: Application rate shall be based on percent of material added as a percentage of the dry unit weight of soil. The application rate shall be determined by a geotechnical engineer. The application rate shall be submitted to the City in the form of a written report prepared by a firm specializing in geotechnical engineering and sealed by a geotechnical engineer. The report shall be submitted at least 30 days prior to any subgrade stabilization work on site.

1.04.2 **By-Product Lime (non-hydrated) / Lime Kiln Dust (LKD):** Application rate shall be based on percent of material added as a percentage of the dry unit weight of soil. The application rate shall be determined by a geotechnical engineer. The application rate shall be submitted to the City in the form of a written report prepared by a firm specializing in geotechnical engineering and sealed by a geotechnical engineer. The report shall be submitted at least 30 days prior to any subgrade stabilization work on site.

1.04.2 **TOLERANCES.** At final compaction, the chemical and water content for each course of subgrade treatment shall conform to the following tolerances:

Material	Tolerance
Cement/LKD	At or above target application
Water	+2% to +4% over Optimum Moisture Content

If material application rate of cement or LKD exceeds the target application rate by 0.5% or more, then the Contractor shall provide new soil moisture-density tests to evaluate relative compaction and moisture content at the actual application rate in the field.

1.04.3 **THICKNESS.** The thickness of the completed, compacted chemical/soil mixture shall be no less than 9 inches, and meet or exceed the depths called out in the plans or specifications. If when checked for minimum thickness it is found to be less than the ½ inch tolerance the contractor shall correct the area represented by the checked location.

1.05 EQUIPMENT

1.05.1 **EQUIPMENT.** The machinery, tools, and equipment necessary for proper execution of the work shall be on the project and approved by the Engineer prior to beginning construction operations.

Blending of the soil-cement mixture shall be accomplished by self-propelled, high power

rotary mixer capable of mixing to a depth of 16 inches. The cutting drum should be fitted with cutting teeth capable of trimming earth, aggregate, and bituminous mixtures. Mixing equipment shall be designed to accurately adjust vertical depth, hold vertical depth, and not develop center deflection of more than 1/8-inch across the width of the mixing drum.

Compaction shall be achieved using padfoot roller. Smoothing and shaping shall be accomplished using a motor grader. Finish rolling shall be done using a smooth steel wheel roller.

Spreaders and distributors shall be used to apply chemical shall be able to demonstrate consistent and accurate application rates, as well as dust control during application. Spreaders and distributors shall be equipped with screw-type augers that can evenly spread material over the width of the rotary mixing drum. Augers may typically feed into a rotary spreader, all spreading equipment shall be equipped with metering devices. Additional dust collection systems may be required at the direction of the Engineer.

All machinery, tools and equipment use shall be maintained in a satisfactory and workmanlike manner.

Cement and LKD shall be stored and handled in closed weatherproof containers until immediately before distribution. Materials exposed to moisture prior to mixing with soils shall be discarded.

1.06 CONSTRUCTION REQUIREMENTS

1.06.1 **GENERAL.** It is the primary purpose of this specification to secure a completed section of treated material which contains a uniform chemical/soil mixture with no loose or segregated areas; has a uniform density and moisture content: is well bound for its full depth. It shall be the responsibility of the Contractor to regulate the sequence of his/her work; to process a sufficient quantity of material to provide a completed section as shown on plans; to use the proper amounts of chemical; to achieve final compaction within the specified time; to maintain the work; and to rework the lifts as necessary to meet the above requirements.

1.06.2 **WEATHER LIMATATION.** The modified soil shall be constructed when the temperature of the soil, measured 6 inches below the surface, is above 50°F and the ambient air temperature is above 40°F. The compacted soil mixture shall be protected from freezing during the curing period.

The quantity of modified soil constructed shall be limited to that which can be covered by full thickness of PCC or AC pavement during the same construction season.

1.06.3 **PREPARATION OF SUBGRADE.** Before other construction operations are begun, the area where the chemical stabilization material will be placed shall be cut and shaped

in conformance with the lines and grades shown on the plans. Grades shall accommodate potential volumetric expansion of stabilized material.

All areas shall be firm and able to support, without displacement, the construction equipment and the compaction hereinafter specified. Soft or yielding subgrade shall be corrected and made stable by scarifying, adding addition chemical, and compacting until it is of uniform stability.

1.06.4 **MOISTURE CONTROL.** Moisture control shall be achieved through use of a rotary mixer equipped with a spray bar in the mixing drum capable of applying sufficient quantities of water to achieve the required moisture content for the soil-chemical mixture. The system shall be capable of being regulated to the degree necessary as to maintain moisture contents within the recommended range.

Required moisture contents will be established by the Engineer based on laboratory tests with the site soils and chemical application rates to be used for the treatment. Final moisture content of the mix, immediately prior to compaction shall meet the specified range of moisture contents. If moisture content exceeds the specified limits, additional chemical may be incorporated to lower moisture contents to the required limits. Lowering moisture contents by aeration following addition of chemicals will not be allowed.

1.06.5 **APPLICATION OF PORTLAND CEMENT or LKD.** Immediately prior to application of Portland Cement or LKD, the areas shall be bladed to allow uniform distribution of material. The chemical shall be spread only on that area where the complete placement operation can be completed within 2 hours.

The chemical shall be spread uniformly over the top of the subgrade by an approved spreader truck. Dumping material on site and spreading with a blade shall not be allowed.

Material shall not be applied when wind conditions, in the opinion of the Engineer, are detrimental to a proper application or becomes objectionable to adjacent property owners or creates a hazard to traffic.

1.06.6 **MIXING.** The mixing procedure utilized shall be Dry Placing as hereinafter described.

The full depth of the treated subgrade shall be mixed with a rotary mixer to the full depth of stabilization as shown on the plans and specifications. Time from Portland Cement or LKD placement on the soil to the start of mixing shall not exceed 30 minutes.

In some cases, in situ moisture content is sufficient to meet specifications. If additional water is needed during mixing, water shall be injected directly into the mixing drum. The system shall be capable of being regulated to the degree as to maintain moisture contents within the recommended range.

Mixing will continue until the material is uniformly mixed, moisture conditioned and form a homogeneous layer with particle sizes meeting the following requirements:

Sieve Size	Minimum Percent Passing
1" inch (25 mm)	100
No. 4 (4.75 mm)	60%

All chemicals and soils may require different mixing patterns, may require multiple passes, or may require different techniques to achieve optimal results.

1.06.7 **COMPACTION.** Compaction of the soil-chemical mixture shall begin immediately after mixing of the cement or LKD. Initial compaction shall be achieved using vibratory pad foot roller capable of compacting the entire depth of the mixture. Following the pad foot roller, the motor grader shall shape the area to consistent grade and cross slope in accordance with the project plans. Following the motor grader, a vibratory smooth drum roller compacts and seals the surface of the treated subgrade. Compaction shall be completed within one hour following incorporation of chemical.

A test for both density and moisture content of the soil-chemical mixture shall be taken for each 750 square yards of material placed. Stabilized soil shall be compacted to at least 95% of the soils maximum laboratory density (ASTM D698).

All irregularities, depressions, or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding or removing material as required and remixing and re-compacting with additional cement or LKD if beyond the 2 hour limit. The surface of the course shall be maintained in a smooth condition, free from undulations and ruts, until other work is placed thereon or the work is accepted.

In addition to the requirements specified for density and moisture, the full depth of the material shown on the plans shall be compacted to the extent necessary to remain firm and stable under construction equipment. After each section is completed, tests will be made by the testing lab. If the material fails to meet the density requirements, it shall be reworked to meet these requirements. Throughout this entire operation, the shape of the course shall be maintained by blading, and the surface upon completion shall be smooth and shall conform with the typical section shown on the plans and to established lines and grades. Should the material, due to any reason or cause, lose the required stability, density and finish before the work is accepted, it shall be reprocessed, re-compacted and refinished at the sole expense of the Contractor. Reprocessing shall follow the same pattern as the initial stabilization including the addition of cement or LKD.

1.06.8 **FINISHING AND CURING.** After the final layer or course of the chemically treated subgrade has been compacted and cured, it shall be brought to the required lines and grades in accordance with the typical sections. The finished surface shall not vary more than 3/8 inch when tested with a 16-foot straightedge applied parallel with and at right angles to the pavement centerline. Any variations in excess of this tolerance shall be

corrected by the Contractor, at his/her own expense, in a manner satisfactory to the Engineer.

After the chemically treated course has been finished as specified herein, the surface shall be protected against rapid drying by either of the following methods for a period of not less than three days or until the pavement section is placed.

1) Maintain in a thorough and continuously moist condition by sprinkling.

2) Spray a quick setting, trackless tack coat over the entire surface.

3) Placement of the aggregate base layer

1.07 MAINTENANCE.

1.07.1 The contractor shall maintain, at his/her own expense, the entire treated subgrade in good condition from the start of work until all the work has been completed, cured, and the pavement is placed. Heavy equipment shall not be allowed on the treated subgrade until capable of supporting the loads.

1.08 TESTING & OBSERVATION.

1.08.1 Tests shall be performed by an independent, accredited testing lab meeting A2LA, AMRL, AASHTO, AWWA, CCRL, or meeting other governing accreditation agencies recognized by the MoDOT, MDNR, or USACE. The testing lab shall also provide testing of the constructed stabilization and provide a certification to the city stating that all stabilization meets or exceeds the requirements of the project. The certification report shall include testing reports that include the moisture/density curves for the mixture, in place moisture and density test results, results of re-tests, field notes assuring the correct quantity of cement or LKD was incorporated, that mixing and compaction were completed specified the time limits in this specification, temperature and weather requirements were met, the stabilized lay was not subject to freezing during the curing process, and that the minimum thickness was placed.

END OF SECTION

DIVISION II
CONSTRUCTION AND MATERIAL SPECIFICATIONS
SECTION 2200 PAVING

APPROVED AND ADOPTED THIS 15th DAY OF FEBRUARY, 2017

KANSAS CITY METROPOLITAN CHAPTER
OF THE AMERICAN PUBLIC WORKS ASSOCIATION

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SECTION 2201 SUBGRADE PREPARATION

2201.1 Scope

This section governs the furnishing of all labor, materials and equipment for the preparation of subgrade as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions. This section includes subgrade preparation at locations which have been previously graded in accordance with the requirements of Section 2100 "Grading and Site Preparation".

2201.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

ASTM

D 698 Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))

2201.3 Definitions

A. Subgrade: Subgrade is defined as a well graded and compacted layer on which base and subsequent courses are placed.

B. Subgrade Preparation: Subgrade preparation is the repeated operation of fine-grading and compacting the subgrade until the specified lines, grades, and cross-section, as indicated on the Plans are obtained and the materials are compacted to the specified depth and density.

2201.4 Construction

A. General: The subgrade surface shall be brought to the specified lines, grades and cross-section by adding or removing material and compacting to the specified density. Tolerance allowed on all lines, grades and cross-sections shall be no more than 1/4 inch.

B. Compacting the Subgrade: Unless otherwise specified, the top 6 inches of subgrade for pavements shall be compacted to 95% of the standard proctor maximum density for the material used as determined by ASTM D 698 and within a tolerance of plus 3% and minus 3% of the optimum moisture content. The tolerance applies only to the top 6 inches.

C. Protection and Maintenance of Subgrade: The subgrade shall be protected from action of the elements or others. Any action (e.g. settlement or erosion) that damages the subgrade or any subgrade that has become unacceptable prior to placing the pavement thereon, shall be repaired and the specific lines, grades, cross-section, tolerance, density, and moisture content range reestablished.

D. Cleanup: Subgrade cleanup shall follow the work progressively. The Contractor shall remove from the project site all rubbish, surplus or discarded material, unsuitable material, and any equipment, tools and temporary construction items used for the preparation of the subgrade.

E. Roll Testing: Once the subgrade has been brought to the final plan elevation, but prior to approval of the

subgrade for paving, all lanes shall be roll tested in their entire length. The subgrade will not be acceptable if rutting, pumping, or deformation of the subgrade results from the roll test. This testing will be done by the contractor, and will be in addition to the applicable moisture and density testing.

Equipment for roll testing shall be a tandem dump truck (one front and two rear axles) carrying a minimum load of twenty (20) tons.

The truck shall proceed slowly along each traffic lane, allowing the Engineer to walk alongside and observe the results. Areas failing the roll test will be reworked and retested prior to approval of the subgrade for paving.

2201.5 Method of Measurement

Subgrade Preparation will generally not be listed in the Contract Documents as a separate item.

2201.6 Basis of Payment

Subgrade Preparation will generally be included in payment for other items in the Contract Documents.

SECTION 2202 SUBGRADE STABILIZATION

2202.1 Scope

This section governs the furnishing of all labor, materials and equipment for the stabilization of subgrade as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions. This work shall consist of the addition of self-cementing fly ash or lime to soil, mixing and compacting the material to the required density to develop a stabilized subgrade section. This applies to natural ground or fills and shall be constructed as specified herein and in conformity with the typical sections, lines and grades as shown on the Plans or as established by the Engineer.

2202.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

ASTM
C 25 Standard Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime
C 618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
D 698 Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))
D 1556 Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
D 5239 Standard Practice for Characterizing Fly Ash for Use in Soil Stabilization
D 6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

AASHTO
T 99 Standard Method of Test for Moisture-Density Relations of Soils Using a 5.5 lb. Rammer and a 12 inch Drop
M 216 Standard Specification for Lime for Soil Stabilization

2202.3 Materials

A. Fly Ash: Fly Ash shall comply with the physical requirements of ASTM D 5239, paragraph 6.4 maintaining a minimum compressive strength of 500 psi at 7 days and the chemical requirements of ASTM C 618, Table 1 for Class C fly ash, unless otherwise shown on the Plans. The source of the ash shall be selected by the Contractor and approved by the Engineer in advance of stabilization operations in order that the required laboratory tests can be completed prior to construction without delaying the work. Certification shall be provided by the supplier that the fly ash used on the project meets the above criteria. Fly ash shall be stored and handled in closed weatherproof containers until distribution. Fly ash exposed to moisture prior to mixing with soils shall be discarded.

B. Lime: Lime shall be hydrated or quicklime conforming to the requirements of AASHTO M 216. Contractor shall provide certification that the product complies. Hydrated lime shall contain not less than ninety (90) percent calcium hydroxide Ca(OH)2, and quicklime shall have a minimum available lime percentage (CaO) of 90%, as determined by ASTM C 25. Lime shall be introduced to the subgrade in a slurry form. When quicklime is used, slake it at the jobsite to manufacture hydrated lime slurry. The Contractor shall submit calculations to the Engineer that determines the amount of water needed to make a slurry with a percent solids between 20 and 40 percent. The Contractor will then determine the concentration strength of the lime slurry and the rate of application to obtain the lime percentage specified in the Contract Documents.

C. Water: Water used for mixing shall be clean and potable. For lime stabilization, it shall be added during mixing, remixing and compaction operations, and during the curing period to keep the cured material moist until covered. If water is not included in the Contract Documents as a pay item, it is subsidiary to other Contract items.

D. Soil: The subgrade soil to be stabilized shall be uniform in quality and gradation and free from rubble, rubbish, vegetation, and stones larger than 1” diameter.

2202.4 Composition

Fly ash shall be applied at a rate determined by laboratory testing using the materials from the site and the specific fly ash to be supplied unless otherwise designated by the Contract Documents. Testing shall be the responsibility of the Contractor and is subsidiary to other items. The minimum application rate shall be 15% unless testing indicates otherwise.

Lime shall be applied at a rate determined by laboratory testing using the materials from the site and the specific lime to be supplied unless otherwise designated by the Contract Documents. Testing shall be the responsibility of the Contractor and is subsidiary to other items. The minimum application rate shall be 5% (by weight) unless testing indicates otherwise.

2202.5 Thickness

The thickness of the completed, compacted soil mixture shall be 6 inches or as called out in the Plans or Special Provisions. The thickness shall not be less than the specified minimum. Check thickness and when found to be ½ inch or more out of tolerance, the contractor shall correct the area represented by the checked location at no additional cost.

2202.6 Equipment

The machinery, tools, and equipment necessary for proper execution of the work shall be on the project and approved by the Engineer prior to beginning construction operations. Utilize spreading equipment capable of producing a consistent

application rate. Blending of the soil mixture shall be accomplished by equipment with a recycling or mixing drum, positive depth control, and automatic water proportioning system that provides consistent results. Compaction shall be achieved using pneumatic or vibratory sheepsfoot or padfoot rollers capable of meeting the compaction requirements. Final surface compaction may be completed with a steel wheel or rubber-tired roller.

All machinery, tools and equipment use shall be maintained in a satisfactory and workmanlike manner.

2202.7 Construction

A. General: It is the primary purpose of this specification to secure a completed section of treated material which contains a uniform mixture with no loose or segregated areas, has a uniform density and moisture content and is well bound for its full depth. It shall be the responsibility of the Contractor to regulate the sequence of his/her work, to process a sufficient quantity of material to provide a completed section as shown on plans, to use the proper amounts of fly ash or lime, to achieve final compaction within the specified time, to maintain the work, and to rework the lifts as necessary to meet the above requirements.

B. Weather Limitations**:** The soil mixture shall not be mixed while the soil is frozen, the temperature is below 40°F or when conditions indicate that the atmospheric temperatures may fall below 40°F within 24 hours.

C. Preparation of Subgrade: Before other construction operations are begun, the area to be stabilized shall be cut and shaped in conformance with the lines and grades shown on the plans. All areas shall be firm and able to support, without displacement, the construction equipment and the compaction hereinafter specified. Soft or yielding subgrade shall be corrected by the Contractor using a method approved by the Engineer.

D. Moisture Control: Moisture control shall be achieved through use of a controllable water additive system capable of being regulated to the degree necessary to maintain moisture contents within the recommended range.

1. For fly ash, the required moisture content will be established by laboratory tests with the site soils and specific fly ash to be used, determined in accordance with ASTM D 698 or AASHTO T 99. Laboratory testing shall be the responsibility of the Contractor and is subsidiary to other items. Final moisture content of the mix, immediately prior to compaction shall be +/- 3 percentage points of the optimum moisture content as determined by laboratory testing unless otherwise specified in the Contract Documents. If moisture contents exceed the specified limits, additional fly ash may be incorporated to lower moisture contents to the required limits. Lowering moisture contents by aeration following addition of fly ash will not be allowed.

2. For lime, the required final moisture content of the lime-soil mix will be established by laboratory tests with the site soils and specific lime to be used, determined in accordance with ASTM D 698 or AASHTO T 99. Laboratory testing shall be the responsibility of the Contractor and is subsidiary to other items. During mixing and compaction operations, the moisture content of the mix shall be a minimum of 3 percentage points above the optimum moisture content as determined by laboratory testing, unless otherwise specified in the Contract Documents. After completion of the preliminary mixing operation and during the aging period, the surface shall be kept moist by spraying with water. Following the final mixing operation and compaction, the surface shall be kept moist by spraying with water until covered by a subsequent layer of material or sealed with a bituminous prime coat applied at a minimum rate of 0.15 gallons per square yard. Other curing methods may be submitted by the Contractor for consideration by the Engineer.

E. Application of Material

1. Fly Ash: Immediately prior to application of fly ash, the areas shall be scarified to allow for uniform distribution. The use of scarification equipment with positive depth control is required and should be performed to a depth between four inches (4") and one inch (1") less than the specified depth of treatment. The fly ash shall be spread only on that area where the placement, mixing and compaction operations can be completed within 2 hours.

   The fly ash shall be spread uniformly over the top of the subgrade – the use of a controlled application system approved by the Engineer is preferred but the Contractor may submit an alternate method of spreading for approval that provides uniform distribution at the specified rate of application. The amount of fly ash spread shall be the amount required for mixing to the specified depth which will result in the percentage determined by laboratory testing as described in section 2202.4 Composition.

   The fly ash shall be distributed in a manner that reduces the scattering of fly ash by wind to a minimum. Fly ash shall not be applied when wind conditions, in the opinion of the Engineer, are detrimental to a proper application or becomes objectionable to adjacent property owners.

   The mixing operation shall be completed within 30 minutes of the addition of water to the subgrade.

2. Lime: Immediately prior to the application of the lime, the areas shall be scarified to allow for uniform distribution. The use of scarification equipment with positive depth control is required and should be performed to a depth between four inches (4") and one inch (1") less than the specified depth of treatment.

   Lime slurry is to be applied with equipment that can regulate the amount passing through the nozzles and the speed of travel to place the specified amount on the soil with a uniform lime distribution. The concentration of the lime slurry should allow for the application of the correct quantity of lime without adding an undue amount of excess moisture. The Contractor is responsible for testing the concentration of the lime suspension a minimum of once per day or once per batch, whichever is greater.

   Application of the lime slurry should occur on the same day the slurry is produced. Continuously agitate the lime slurry once it is produced.

F. Mixing

1. Fly Ash: The full depth of the treated subgrade shall be mixed with a rotary pulvamixer which utilizes a direct hydraulic drive. Fly ash shall not be left exposed for more than 30 minutes after distribution. Water shall be added through a spray bar in the mixing drum capable of uniformly applying sufficient quantities of water to achieve the required moisture content of the soil-fly ash mixture. The system shall be capable of being regulated to maintain moisture contents within the recommended range.

   Mixing shall continue until a homogeneous, friable mixture with zero clods greater than 1-1/2" in size remain and no more than 50% of the mixture is retained on a ½" sieve.

2. Lime: The mixing process for lime includes preliminary mixing, aging, and final mixing. The preliminary mixing should occur immediately following the introduction of the lime slurry to the subgrade. The equipment used for mixing shall have positive depth control with a visual depth indicator and be capable of mixing the full specified depth of treatment to within ½" tolerance. The mixing equipment should also have a travel speed indicator and controllable water additive system. Preliminary mixing shall continue until the material is uniformly mixed, at a minimum moisture content of 3% above

optimum and with zero clods greater than 2" in size remaining. Perform a minimum of two passes over all treated areas with the mixer. Upon completion of the preliminary mixing, seal the mixture to prevent moisture loss by lightly rolling with a pneumatic or steel drum flat roller.

Aging should occur for a minimum of 24 hours and a maximum of 72 hours unless approved otherwise by the Engineer.

Following the aging period, the final mixing is performed by re-mixing the entire treated area until the mixture contains zero clods greater than 1.5" and has 95% of the mixture passing the 1" sieve and 60% of the mixture passing the No. 4 sieve. The mixture should be brought to a moisture content of a minimum of 3% above optimum for compaction.

G. Compaction

1. Fly ash: Compaction of the soil-fly ash mixture shall begin immediately after mixing of the fly ash and be completed within two hours following incorporation of fly ash. Compaction of the mixture shall continue until the entire depth of mixture is uniformly compacted to the specified density using vibratory sheepsfoot or pad foot rollers. A pneumatic rubber tire or smooth wheel steel drum roller may be used to complete the compaction of the surface. A test for both density and moisture content of the soil-fly ash mixture shall be taken for each 750 square yards of material placed with a minimum of one test per day of production. The field density of the compacted mixture shall be at least 95 percent of the maximum density established by laboratory tests using the site soils and specific fly ash to be used, determined in accordance with ASTM D 698. Laboratory testing shall be the responsibility of the Contractor and is subsidiary to other items.

   The in-place field density shall be determined in accordance with ASTM D 1556 or ASTM D 6938. When ASTM D 6938 is utilized for testing purposes, the nuclear gauge shall be calibrated within the last year. Calibration and operation of the gauge shall be in accordance with the requirements of the manufacturer. The operator of the nuclear gauge must show evidence of training and experience in the use of the instrument. The gauge shall be standardized daily in accordance with ASTM D 6938, paragraph 8.

   Final acceptance of the compaction is dependent upon passing visual roll testing. This will be observed and approved by the Engineer. All irregularities, depressions, or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding or removing material as required and remixing and re-compacting with additional fly ash if beyond the 2 hour limit. The surface of the course shall be maintained in a smooth condition, free from undulations and ruts, until other work is placed thereon or the work is accepted.

   Should the material, due to any reason or cause, lose the required stability, density and finish before the work is accepted, it shall be reprocessed, recompacted and refinished at the sole expense of the Contractor. Reprocessing shall follow the same pattern as the initial stabilization including the addition of fly ash.

2. Lime: Compaction of the soil-lime mixture shall begin immediately after final mixing. Compaction of the mixture shall continue until the entire depth of mixture is uniformly compacted to the specified density using vibratory sheepsfoot or pad foot rollers. A pneumatic rubber tire or smooth wheel steel drum roller may be used to complete the compaction of the surface. A test for both density and moisture content of the soil-lime mixture shall be taken for each 750 square yards of material placed with a minimum of one test per day of production. The field density of the compacted mixture shall be at least 95 percent of the maximum density established by laboratory tests using the site soils and

specific lime to be used, determined in accordance with ASTM D 698. Laboratory testing shall be the responsibility of the Contractor and is subsidiary to other items.

The in-place field density shall be determined in accordance with ASTM D 1556 or ASTM D 6938. When ASTM D 6938 is utilized for testing purposes, the nuclear gauge shall be calibrated within the last year. Calibration and operation of the gauge shall be in accordance with the requirements of the manufacturer. The operator of the nuclear gauge must show evidence of training and experience in the use of the instrument. The gauge shall be standardized daily in accordance with ASTM D 6938, paragraph 8.

Final acceptance of the compaction is dependent upon passing visual roll testing. This will be observed and approved by the Engineer. All irregularities, depressions, or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding or removing material as required and remixing and re-compacting.

The surface of the course shall be maintained in a smooth condition, free from undulations and ruts, until other work is placed thereon or the work is accepted.

Should the material, due to any reason or cause, lose the required stability, density and finish before the work is accepted, it shall be reprocessed, recompacted and refinished at the sole expense of the Contractor.

H. Finishing (Trimming) & Curing

1. Fly ash: After each layer or course of the fly ash treated subgrade has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections. The finished surface of the final layer shall not vary more than 3/8 inch when tested with a 10-foot straightedge applied parallel with and at right angles to the pavement centerline. Any variations in excess of this tolerance shall be corrected by the Contractor, at his/her own expense, in a manner satisfactory to the Engineer.

   After the fly ash treated course has been finished as specified herein, the surface shall be protected against rapid drying by one of the following methods for a period of not less than three days or until the pavement section is placed.

   a. Maintain in a thorough and continuously moist condition by sprinkling with water.
   b. Apply an asphalt prime coat emulsion curing seal approved by the Engineer at a rate of 0.15 gallons per square yard.
   c. Other options for maintaining moisture may be submitted in writing for approval by the Engineer.

   Restrict construction traffic from operating on the treated subgrade until it can withstand the loads without damage or deformation.

   Protect the treated subgrade from freezing throughout the protection period.

2. Lime: After each layer or course of the lime treated subgrade has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections. The finished surface of the final layer shall not vary more than 3/8 inch when tested with a 10-foot straightedge applied parallel with and at right angles to the pavement centerline. Any variations in excess of this tolerance shall be corrected by the Contractor, at his/her own expense, in a manner satisfactory to the Engineer. After the lime treated course has been finished as specified herein, the surface shall be cured by one of the

following methods for a period of not less than three days and maintained until placement of the subsequent course (base or pavement) or up to seven days, whichever occurs first:

a. Maintain in a thorough and continuously moist condition by sprinkling with water.
b. Apply an asphalt prime coat emulsion curing seal approved by the Engineer at a rate of 0.15 gallons per square yard.
c. Other options for a curing seal may be submitted in writing for approval by the Engineer.

Restrict all construction traffic (except watering equipment) from operating on the treated subgrade during the curing period. Restriction may be lifted after three days if treated subgrade has gained sufficient strength to withstand the loads without damage or deformation.

Protect the subgrade from freezing throughout the curing period.

I. Maintenance: The contractor shall maintain, at his/her own expense, the entire treated subgrade in good condition from the start of work until all the work has been completed, cured, and the pavement is placed.

2202.8 Method of Measurement

The amount of completed and accepted work will be measured or determined as follows:

A. Lime: Per ton or tenth part thereof for the specified depth.

1. For bag lime, use the net weight on the bag.

2. For certified truck or rail car quantity, use the net weight of lime.

3. For hydrated lime slaked at the jobsite, use the quantity calculated in Section 2202.4, correcting for purity and inert material.

B. Fly Ash: Per ton or tenth part thereof for the specified depth.

C. Manipulation (Lime Treated Subgrade or Fly Ash Treated Subgrade): Per square yard or tenth part thereof.

D. Water: Per M Gallon (1,000 Gallons) using calibrated tanks or water meters.

1. For lime treated subgrade, measure water used for mixing, moisture control and curing but do not measure water used for slaking the lime, dust control, or excess water used due to Contractor negligence.

2. For Fly Ash treated subgrade, measure water used for mixing, moisture control and protection but do not measure water used for dust control or excess water used due to Contractor negligence.

E. Alternate curing (lime) and protection (fly ash) of subgrade: No measurement will be made if the Contractor elects to use asphalt prime coat emulsion or other alternative method for curing or protection of subgrade. These are subsidiary to other Contract Documents.

2202.9 Basis of Payment

Payment for the completed and accepted work will be made as follows when included in the Contract Documents:

A. Lime will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

B. Fly Ash will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

C. Manipulation (Lime Treated Subgrade or Fly Ash Treated Subgrade) will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

D. Water will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

SECTION 2203 AGGREGATE BASE COURSE

2203.1 Scope

This section governs the furnishing of all labor, materials and equipment for the placement of aggregate base course and underdrains, including pipe, geotextiles and granular filter material as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2203.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

ASTM

C 31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
C 33	Standard Specification for Concrete Aggregates
C 39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
C 88	Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
C 117	Test Method for Materials Finer than 75 µm (No. 200) Sieve in Mineral Aggregates by Washing
C 131	Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
C 136	Test Method for Sieve Analysis of Fine and Coarse Aggregates
C 142	Test Method for Clay Lumps and Friable Particles in Aggregates
C 150	Standard Specification for Portland Cement
D 75	Practice for Sampling Aggregates

D 695 Test Method for Compressive Properties of Rigid Plastics
D 1621 Test Method for Compressive Properties Of Rigid Cellular Plastics
D 2419 Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
D 3034 Specification for Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings
D 3666 Specification for Minimum Requirements for Agencies Testing and Inspecting Bituminous Paving Materials
D 4318 Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
D 4716 Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
D 4791 Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
D 5821 Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
F 758 Standard Specification for Smooth-Wall Polyvinyl Chloride (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage

AASHTO
M 252 Corrugated Polyethylene Drainage Tubing
T 99 The Moisture-Density Relations of Soils Using a 5.5-lb. (2.5 kg) Rammer and a 12-in. (305 mm) Drop

2203.3 Materials

A. Untreated Compacted Aggregate: This base course material shall consist of crushed stone aggregate with not more than 1.0% clay lumps and friable particles in accordance with ASTM C 142, and free from vegetable or other deleterious substances. The abrasion loss shall be no more than 35% when tested in accordance with ASTM C 131. That fraction passing the 1 inch sieve and retained on the No. 4 sieve shall have a loss not greater than 18% by weighted average for magnesium sulfate method (12% maximum loss if tested using sodium sulfate method) of ASTM C 88 Soundness Test at 5 cycles. That fraction of the material passing the 1-inch sieve and retained on the No. 4 sieve shall contain less than 20% by weight of flat and elongated particles when tested in accordance with ASTM D 4791 (flat being a ratio of 1 to 3 between thickness and least width and a ratio of 1 to 3 between the least width and length). The material shall consist of angular particles with no less than 90% of particle count having two or more fractured surfaces. The gradation in percentages by weight passing square mesh sieves shall be in accordance with ASTM C 136 and as follows:

Sieve Designation (Square Opening)	Percentage by Weight Passing Sieve
1-1/4 in (31.5 mm)	100
1 in (25.0 mm)	72 – 100
3/4 in (19.0 mm)	60 – 90
3/8 in (9.5 mm)	43 – 74
No. 4 (4.75 mm)	28 – 60
No. 10 (2.00 mm)	16 – 40
No. 40 (425 um)	3 – 22
No. 200 (75 um)	0 – 15

In addition to the above limits, the difference between the "Percent Passing Square Mesh Sieve" of successive sieve sizes shall not exceed 25 percent.

That fraction of the material passing the No. 40 sieve shall have a plasticity index not to exceed 8 when tested in accordance with ASTM D 4318.

B. Drainable Base: All drainable base materials shall have a minimum coefficient of permeability of 1000 ft/day as

determined by the test method described in 2203.4.E Permeability Test Procedure.

1. Portland Cement Concrete Drainable Base: This item shall consist of an open-graded drainable base composed of mineral aggregate, Portland cement and water mixed in a central mixing plant and placed on a prepared course in accordance with these specifications and shall conform to the lines, grades, thicknesses and typical cross sections shown on the Plans.

    a. Coarse Aggregate
        i. General: Coarse aggregate shall be 3/4 inch maximum size consisting of crushed gravel or crushed stone and shall meet the requirements of ASTM C 33 and quality requirements of 2203.3.A.
        ii. Gradation shall be ASTM C 33, Size 67.
    b. Fine Aggregate: Fine aggregate shall consist of natural sand or manufactured sand meeting the requirements of ASTM C 33.
    c. Cement: Portland cement shall conform to the requirements of ASTM C 150, Type I or Type II. Substitution of fly ash or other pozzolan for Portland cement shall be in conformance with Section 2208.
    d. Water: Water used in mixing or curing shall be clean and free of oil, salt, acid, alkali, sugar, vegetable or other substances injurious to the finished product as possible. Water known to be of potable quality may be used without testing.
    e. Admixtures: The use of any material to be added to the mixture shall be approved by the Engineer.
    f. The Contractor shall furnish vendor's certified test reports for the materials used in the project. The report shall be delivered to the Engineer as part of the mix design before permission to use the materials is granted.
    g. Proportions: The Contractor shall submit a mix design containing the quantity of each material to the Engineer including certifications of materials used. The Contractor will be responsible for preparing the drainable base mix design at no cost to the Owner. The testing laboratory preparing the mix design shall comply with Section 2203.3.B.2.e. The mix design shall include the following:

        Cement Content
        Water-Cement Ratio - Approximately 0.36
        Coarse Aggregate
        Fine Aggregate
        All Admixtures
        Coefficient of Permeability - Tested per Section 2203.4.E

    h. Compressive Strength: Proportions will be such to produce a compressive strength of 800 psi in 28 days as determined by test cylinders made in accordance with ASTM C 31 and tested in accordance with ASTM C 39. A strength of 500 psi will be required prior to any traffic being allowed on the surface.

2. Plant Mix Bituminous Drainable Base: This item shall consist of an asphalt stabilized drainable base course composed of mineral aggregate and bituminous material mixed in a central mixing plant and placed on a prepared course in accordance with the specifications and shall conform to the lines, grades, thicknesses, and typical cross sections shown on the Plans. Each course shall be constructed to the depth, typical section, or elevation required by the Plans and shall be rolled, finished, and approved before the placement of the next course. A prime coat will be used on the subbase prior to placement of the first course, and no tack coat will be used between courses.

a. Aggregate: Aggregate shall consist of crushed stone or crushed gravel and be free of organic materials.
   i. Coarse Aggregate: Coarse aggregate shall comply with Section 2303.3.A except wear may not exceed 50 % in accordance with ASTM C 131.
   ii. Aggregate shall contain at least 70% by weight of individual pieces having two fractured faces and 85% by weight having at least one fractured face as determined by ASTM D 5821.
   iii. The aggregate shall not contain more than 8%, by weight, of flat and elongated pieces, when tested in accordance with ASTM D 4791 (ratio = 5:1).
   iv. Sampling: ASTM D 75 shall be used in sampling the coarse aggregate.

b. Bituminous Material: The asphalt cement shall be in conformance with Section 2205.3.A. The type and grade of asphalt used shall be specified in the mix design but shall not be lower than a PG 64-22.

c. Preliminary Material Acceptance: Prior to delivery of materials to the job site, the Contractor shall submit certified test reports to the Engineer for the following materials:

   Coarse Aggregate - Percent of wear, soundness.

   Bituminous Material - The certification(s) shall show the appropriate ASTM test(s) for each material, the test results, and a statement that the material meets the specification requirements.

d. Job Mix Formula. (JMF): No bituminous mixture for payment shall be produced until the Engineer has approved a JMF in writing. The method of determining the proper asphalt content is to store the mix trial batches in the laboratory overnight (15-18 hrs) at 140°F. The proper asphalt content will then be selected visually.

   The asphalt content mix is selected from the batch from which a small amount of asphalt drains to the bottom of the pan and the mix still appears glossy. A heat resistant, clear glass dish may be used for better visibility of the drained asphalt. The asphalt content may be varied as necessary during construction to meet this requirement.

   The aggregate shall be of such size that the percentage composition by weight will conform to the gradation of gradations specified in Table 2, when tested in accordance with ASTM C 117 and C 136. The gradation shall be on the coarse side of the Master Band.

TABLE 2. PLANT MIX BITUMINOUS DRAINABLE BASE MASTER GRADATION

Sieve Designation (Square Opening)	Percent by Weight Passing Sieve
1-1/2 in (37.5 mm)	100
1 in (25.4 mm)	90 – 100
3/4 in (19.0 mm)	75 – 100
1/2 in (12.5 mm)	70 – 90
3/8 in (9.5 mm)	50 – 70
No. 4 (4.75 mm)	20 – 40
No. 8 (2.36 mm)	15 – 25
No. 30 (637 um)	5 – 15
No. 200 (75 um)	0 – 3

Recommended Asphalt Cement Content 2.0% – 3.5%

The gradations in Table 2 represent the limits that shall determine the suitability of aggregate for use from the supply source.

The job mix tolerance shown in Table 3 shall be applied to the JMF to establish a job control-grading band. The resulting job control grading band must comply with the Master Gradation criteria.

TABLE 3. JOB MIX FORMULA TOLERANCES (Based on Single Test)

Material	Tolerance Plus or Minus
Aggregate passing No. 4 (4.75 mm) sieve or larger	5.00%
Bitumen*	0.40%
Temperature*	20 degrees F

*Unless otherwise approved by the Engineer.

The aggregate gradation may be adjusted within the limits of Table 2 as directed, without adjustments in the Contract unit prices.

Should a change in sources of materials be made, a new JMF shall be established before the new material is used.

Dry aggregate gradations will be made at least twice daily. The aggregate gradation shall be tested by the Contractor in accordance with ASTM C 117 and C 136 and the results submitted to the Engineer within 24 hours.

The JMF shall be submitted in writing by the Contractor and approved by the Engineer prior to the start of paving operations. The job mix shall have been prepared no more than 12 months prior to submittal and shall include as a minimum:

Percent passing each sieve
Percent of asphalt cement
Asphalt designation and certifications
Mixing temperature
Compaction temperature
Temperature of mix when discharged from the mixer
Percent fractured faces
Percent elongated particles

The Contractor shall submit samples to the Engineer, upon request, for job mix formula verification testing.

e. Testing Laboratory: The laboratory used to develop the JMF formula shall meet the requirements of ASTM D 3666.

C. Underdrains: Underdrains shall consist of the following materials unless otherwise specified in the Plans, Standard Drawings, or Contract Documents.

1. Aggregate: Blanket underdrain aggregate and pipe underdrain aggregate shall be clean or washed

aggregate and conform to requirements of Section 2203.3.A with the following gradations:

TABLE 4. BLANKET UNDERDRAIN AGGREGATE	
Sieve Designation (Square Opening)	Percent by Weight Passing Sieve
1-1/2 in (37.5 mm)	100
1 in (25.4 mm)	90 – 100
3/4 in (19.0 mm)	60 – 90
3/8 in (9.5 mm)	-----
No. 4 (4.75 mm)	20 – 40
No. 8 (2.36 mm)	-----
No. 16 (1.2 mm)	0 – 10
No. 30 (0.6 mm)	-----
No. 50 (0.3 mm)	0 – 7
No. 100 (150 um)	0 – 2

TABLE 5. PIPE UNDERDRAIN AGGREGATE	
Sieve Designation (Square Opening)	Percent by Weight Passing Sieve
1-1/2 in (37.5 mm)	-----
1 in (25.4 mm)	-----
3/4 in (19.0 mm)	100
3/8 in (9.5 mm)	85 – 100
No. 4 (4.75 mm)	-----
No. 8 (2.36 mm)	40 – 60
No. 16 (1.2 mm)	-----
No. 30 (0.6 mm)	5 – 30
No. 50 (0.3 mm)	-----
No. 100 (150 um)	1 – 2

2. Underdrain Pipe

   a. Polyvinyl chloride pipe shall meet the requirements of ASTM F 758/D 3034.
   b. Corrugated Polyethylene Tubing may be used only outside of traffic areas and driving surfaces. The tubing shall be the heavy duty type and shall meet the requirements of AASHTO M 252. In addition, the tubing shall have a minimum pipe stiffness of 30 psi at 10% deflection.
   c. All underdrain pipes shall have a nominal minimum inside diameter of six inches unless shown otherwise on the Plans.
   d. Perforations shall be approximately circular and cleanly cut; shall have nominal diameters not less than 3/16-inch nor more than 3/8-inch; and shall be arranged in at least two rows parallel to the axis of the pipe.
   e. Fittings shall be of the same composition and have the same physical properties as the pipe and shall not restrict flow.

3. Geocomposite Edge Drain

   a. Edge drain shall consist of a plastic core completely surrounded by geotextile. The core shall provide a minimum of 10 percent open area to facilitate water entry or cross flow and shall be composed of plastic which is physically and chemically stable under a normal range of

conditions.

b. The edge drain shall have nominal dimensions of 1 to 1-1/2 inches in thickness and 12 inches in height.

c. The edge drain shall have a minimum flow capacity of 15 gallons per minute per foot of width as determined by ASTM D 4716 when tested under a confining stress of 10 psi or more at a gradient of 0.1 or less.

d. The edge drain shall have a minimum compressive strength of either 7,000 psf at a maximum deformation of 10 percent of the original thickness when tested in accordance with ASTM D 1621, or 8,000 psf at a maximum deformation of 20 percent when tested in accordance with ASTM D 695.

e. Geotextile shall have an apparent opening size (AOS) corresponding to a U.S. sieve number greater than 50 but not exceeding 100.

4. Geotextile: Geotextile for use with pipe and edge underdrains shall be a nonwoven geotextile and shall meet the requirements of Section 2605.2.C.

2203.4 Construction

A. Untreated Compacted Aggregate

1. Subgrade: Prior to placement of base course material the previously prepared subgrade surface shall be cleared of all foreign substances and restored in shape, tolerance and density as specified in Section 2201 entitled "Subgrade Preparation".

2. Material Placement: The material shall be uniformly spread in successive layers to such depth that when compacted, the base will meet the minimum thickness specified. The Contractor may construct the base in any number of layers that he chooses except that in no case shall any individual layer have a compacted thickness of more than 6 inches. Each layer shall be compacted as hereinafter specified before any succeeding layer is placed.

3. After spreading a layer of material, water in an amount sufficient to insure the desired compaction shall be added and uniformly mixed with the aggregate in a manner to prevent segregation. Excess moisture resulting in runoff shall be avoided. If for any reason, the material and subgrade become too wet to permit satisfactory work, they shall be allowed to dry to a moisture content that will permit satisfactory work.

4. The material shall meet the required specifications immediately before compaction operations are commenced. If, for any reason, segregation occurs in excess of 10% variation from the gradation required by this specification or the materials become contaminated, such segregated or contaminated materials shall be removed and replaced with suitable materials at the expense of the Contractor. The limited segregation of 10% variation will be ascertained by a sieve analysis of a minimum 100 pound sample taken from the in-place base course.

5. However, for untreated compacted aggregate base, segregated surface areas may be corrected by adding limestone screenings of such gradation and quantity as required to fill the surface voids and firmly bind the loose material in place. Screenings so used in correcting segregated surface areas will be subsidiary.

6. Shaping and compacting shall be carried on continuously until a true, even and uniform surface of proper grade and cross-section is obtained, and until the density of the complete base is at least 95%

of maximum density as determined by AASHTO T 99. The proper moisture content shall be maintained by wetting the surface as required during shaping and compacting operations. Final rolling shall be accomplished by use of a self-propelled smooth-wheeled roller.

B. Portland Cement Concrete Drainable Base

1. Spreading: The base material shall be spread to the lines and grades shown on the Plans. Any material which becomes mixed with soil or other contaminants shall be removed and replaced with fresh mixture.

2. Compaction: After spreading and/or trimming, the base material shall be uniformly compacted by making a minimum of 2 coverages with a steel wheeled roller meeting the requirements of Section 2205.8.B. The compaction process may be adjusted on the project by the Contractor with approval of the Engineer to assure uniform compaction of the drainable base material. In areas not accessible by the roller, the base material shall be compacted by mechanical hand methods. Compaction must be completed within 2 hours of the time water is introduced to the mixture.

3. If after spreading and compacting the base is not to the required lines and grade, the Contractor shall trim the base by means of an electronically controlled machine utilizing string line controls for grade. The Engineer reserves the right to direct the Contractor to suspend all operations if the Contractor produces excessive fines in the trimming process which are viewed by the Engineer to be detrimental to the permeability of the base. Appropriate corrections to the trimming process shall be made by the Contractor prior to beginning again.

4. After compaction of the drainable base, the Contractor shall protect the surface from damage and/or contamination. If the integrity of the drainable base is disturbed at any time prior to placement of the succeeding pavement course the area shall be removed and replaced with new material and compacted to conform to the original lines and grades at the Contractor's expense. Any removed material shall not be reincorporated into the drainable base or other drainage features.

5. Curing Of The Drainable Base Material: The Contractor will be required to provide a curing plan to the Engineer.

6. Temperature Limitations: The air temperature must be between 50°F and 90°F for drainable base construction. The Engineer may order operations to cease in hot windy conditions if it appears the mixture is drying out prior to achieving initial set.

7. Construction Joints: The formation of all joints shall be made in such a manner as to ensure a continuous bond between old and new sections of the course. All joints shall present the same texture and smoothness as other sections of the course.

8. All contact surfaces of previously constructed courses shall be cleaned of all dirt or other objectionable materials, and thoroughly moistened with water prior to placing the new material.

9. Thickness: The thickness of the base course may be measured by cores taken at intervals determined by the Engineer.

C. Plant Mix Bituminous Drainable Base

1. Test Section: Prior to full production, the Contractor shall prepare and place a section of drainable base according to the JMF. The amount of mixture should be 80 tons and may be placed as part of the

project. The underlying grade or pavement structure upon which the test section is to be constructed shall be the same as the remainder of the course represented by the test section. The equipment used in construction of the test section shall be the same type and weight to be used on the remainder of the course represented by the test section.

2. Two random samples of mixture may be taken at the plant and tested for aggregate gradation and asphalt content. The test section shall be considered acceptable if the gradation and asphalt content are within the limits specified in Tables 2 and 3.

3. If the initial test section should prove to be unsatisfactory to the Engineer, the necessary adjustments to the JMF, plant operation, placing procedures, and/or rolling procedures shall be made. A second test section shall then be placed. If the second test section also does not meet specification requirements, both sections shall be removed at the Contractor's expense. Additional test sections, as required, shall be constructed and evaluated for conformance to the specifications. Any additional sections that do not conform to specification requirements shall be removed at the Contractor's expense. Full production shall not begin until a satisfactory section has been constructed and accepted by the Engineer. The test sections that meet the specification requirements shall be paid for in accordance with project quantities.

4. The Contractor shall perform job mix control testing at the start of plant production and in conjunction with the calibration of the plant for the JMF. It should be recognized that the aggregates produced by the plant may not satisfy the gradation requirements or produce a mix that exactly meets the JMF. In those instances, it will be necessary to reevaluate and redesign the mix using plant-produced aggregates. Specimens should be prepared and the optimum bitumen content determined in the same manner as for the original design tests.

5. Weather Limitations: The bituminous mixture shall not be placed upon a wet surface or when the surface temperature of the underlying course is less than 40 degrees F or the wind chill factor is less than 35 degrees F. The temperature requirements may be waived by the Engineer; however, all other requirements including compaction shall be met.

6. These materials will be placed, handled, hauled and accepted based on requirements of Section 2205.

D. Underdrains

1. General: Underdrains shall be constructed as shown on the Plans or Standard Drawings. The exact location and layout of underdrains and/or edge drains as shown on the Plans shall be subject to revision by the Engineer during construction.

2. Excavation

   a. Trenches for all lateral and longitudinal underdrains shall be excavated to the dimensions, depths and elevations shown on the Plans or Standard Drawings or as ordered by the Engineer. In case of a conflict, where the actual elevation of the strata or stratum to be intercepted is found to vary from Plan elevation, the stratigraphy shall govern in the installation of underdrains.
   b. Trench bottoms for perforated pipe underdrain and edge drain shall be in firm material (no mucky or soupy condition existing) and constructed to permit the placing of three inches (3") of aggregate underneath the pipe. If unstable material is encountered in the bottom of the trench, the trench shall be over excavated to firm material.
   c. Minimum width of trench shall be as shown in the Plans or in the specifications or the

Standard Drawings.

3. Laying Pipe

   a. All underdrain pipe shall be laid carefully to Plan line and grade.
   b. All pipe shall be laid on a minimum grade of one percent unless otherwise shown on the Plans.
   c. All dead ends of pipe underdrains shall be completely closed with a cap of the same material as the pipe.
   d. All junctions and turns shall be made with wyes, tees, and bends as supplied by the manufacturer of the pipe.
   e. Perforations shall be laid down unless otherwise indicated on the Plans.

4. Installing Edge Drain

   a. Installation shall be in accordance with manufacturer's instructions.
   b. Each length of drain shall be joined to the adjacent length prior to installation. Splices shall keep adjoining lengths in proper alignment, shall not separate during installation, shall have the same or greater compressive strength than the geocomposite drain, and shall be sealed against infiltration of backfill material.
   c. Drain shall be placed in the center of the trench and held in place with a temporary support while blanket underdrain aggregate backfill is placed.
   d. The placement of the edge drain and the first lift of backfill shall be accomplished in a single continuous operation.

5. Backfilling

   a. Backfilling the trenches of lateral and longitudinal underdrains shall not be started until approved by the Engineer.
   b. The trenches shall be backfilled to the specified elevations and in accordance with the Plans, specifications or Standard Drawings.
   c. The backfill material shall be placed in such a manner as to prevent formation of large cavities in the backfill and walls of the trench.
   d. Overbreakage due to blasting of rock in trench excavation and widening due to caving of trench walls or overbreakage at construction outcrops shall be backfilled with aggregate approved by the Engineer.

E. Permeability Test Procedure for Drainable Base

This test method is used to determine the permeability of unbound and bound aggregate base material. Bound base material will use Portland cement or asphaltic cement as a cementing agent.

1. Unbound Base and Base Bound with Portland Cement

   a. Apparatus
      i. Mold: A cylindrical metal mold with an approximate inside diameter of 6" and a minimum height of 6". The mold shall be equipped with a removable collar at least 2" in height and a removable base plate. The base plate may be used as part of the permeability test equipment. If so, the base plate must exceed the permeability of the material being tested. A #40 screen shall be placed on top of the base plate to prevent test material from being lost through the base plate during compaction and

permeability testing.

ii. Standpipe: A standpipe with the same diameter as the removable collar for the mold with a minimum height of 8.5". The standpipe shall be equipped with an overflow outlet.

iii. Rammer: A mechanically operated metal rammer equipped to control the height of drop to 12" plus or minus 1/16" above the elevation of the sample. The rammer shall be equipped to distribute the blow uniformly over the sample surface. The rammer shall have a rigid flat faced "pie shaped" foot and a nominal weight of 5.50 lbs. The "pie shaped" foot shall be a sector of 6" diameter circle and shall have an area equal to that of a 2" circular foot.

iv. Straight edge: A rigid steel straight edge with one edge beveled, at least 8" in length.

b. Sample preparation

i. Obtain a 50 lb. to 60 lb. sample, dry if necessary.

ii. Mix a sufficient amount of aggregate and cementing agent, if required, to fill the mold 1 and 1/2 times.

iii. Add the appropriate amount of water and thoroughly mix.

iv. Place the assembled mold on the rigid base and fill approximately 1/2 full of the loose moist material. Compact the layer with 25 blows of the rammer with the blows being distributed uniformly over the surface of the layer. Place three additional approximately equal layers of material in the mold and compact each layer in a similar manner (four layers total).

v. After the fourth layer has been compacted, remove the collar and trim excess material level with top of the mold.

vi. Cure Portland cement treated specimens by covering with plastic, to prevent drying for 3 days at room temperature.

vii. Unbound specimens do not need to be cured before testing.

2. Asphalt Bound Aggregates

a. Apparatus

i. Mold: A cylindrical mold with an inside diameter of approximately 6" and a minimum length of 4.5". The mold is open at each end and is equipped with a removable collar and a base plate about 0.5" thick.

ii. Specimen Mold Holder: The specimen mold holder has a semi-circular base and a flanged top to hold the specimen mold in place during the compaction process. Any equivalent hold down device that performs the same function is satisfactory.

iii. Compaction Hammer: The compaction hammer consists of a hammer having a flat circular tamping face 5.88" in diameter and appropriate extension rod with handle which acts as guide for a free falling weight. The weight shall weigh 22.5 lbs. and have a free fall of 18" plus or minus 0.1". The hammer may be operated manually or be driven with a motor.

iv. Compaction Pedestal: The compaction pedestal is a wood block approximately 12" x 12" x 18". A 12" x 12" x 1" steel plate is securely fastened to the top of the block. The pedestal is set on and securely fastened to a solid concrete slab with the vertical axis plumb and the top level.

v. Heating Equipment: Ovens or hot plates for heating aggregates, bituminous material, specimen molds, compaction hammers and other associated items required for mixing and molding. It is recommended that, when possible all heating units be thermostatically controlled to maintain the required temperature within ±5°F. Suitable shields, thick steel plates or pans of sand shall be used on the surfaces of hot plates to minimize locally overheating.

vi. Mixing Apparatus: Mechanical mixing is recommended. Any type of mechanical mixer may be used provided it will produce a well coated, homogeneous mixture of the required amount in the allowable time and further that the mixing paddle or whip does not fracture or pulverize aggregate fractions during the mixing process. The bowl employed with the mixer shall be such a nature that essentially all of the batch can be removed. More than one mixing bowl is recommended unless the mixer is equipped with a heating jacket to keep the bowl heated during the mixing process.

b. Determination of Mixing and Compacting Temperature

i. The temperature to which the asphalt cement must be heated to produce a viscosity of 85 ± 10 SFS shall be the mixing temperature.

ii. The temperature to which the asphalt cement must be heated to produce a viscosity of 130 ± 15 SFS shall be the compacting temperature.

c. Sample Preparation for Laboratory Prepared Mix

i. Combine the dry individual aggregates to produce desired combined aggregate with a batch weight of approximately 8.9 lbs. This should be sufficient to produce a compacted specimen 3.75 ± 0.125 inches thick. Adjust the weight of the batch as needed to produce a compacted specimen of 3.75 ± 0.125 inches thick.

ii. Prepare a minimum of two aggregate and asphalt specimens. The first specimen shall be mixed and thrown away. This sample is to "butter" the mixing bowl and paddle and thus reduce material loss when mixing the test specimen.

iii. Heat the aggregate and asphalt within the limits of mixing temperature determined in Section 2203.4.E.2.b. Charge the mixing bowl with the heated aggregate and form a crater in the top. Add the required amount asphalt and mix the aggregate and asphalt until coated at least 2 minutes. Care should be taken to keep all of the sample in the mixing bowl during this process.

d. Compaction of Specimen

i. Prior to the addition of the asphalt to the batches, thoroughly clean the specimen mold assembly and the face of the compaction hammer and heat the mold assembly and hammer to a temperature between 200°F and 350°F. Assemble the mold, base plate and collar and place a paper disc cut to size in the bottom of the mold.

ii. Place the hot batch of aggregate-asphalt mixture in the mold, spade vigorously with a heated spatula or trowel 15 times around the perimeter and 10 times over the interior of the mold. Smooth the surface of the mix to a slightly rounded shape. The temperature of the mix prior to compaction shall be within the limits in Section 2203.4.E.2.b. Place a paper disc on top of the mix.

iii. Place the mold assembly, including the collar, on the pedestal, fasten securely with the mold holder and apply 20 blows with the compaction hammer. Each blow must have the prescribed free fall of 18" with the axis of the compaction hammer held perpendicular to the base of the mold assembly during the compaction process. Remove the base plate and collar, and reverse and reassemble the mold. Apply the specified number of blows to the reversed specimen. After compaction remove the mold assembly from the pedestal, remove the collar and base plate and cool the specimen in the mold until the mold can be handled comfortably with bare hands. Asphalt treated samples do not need to be cured before testing, only cool to the touch.

3. Test Procedure

a. Assemble test equipment, base plate, mold with specimen, and standpipe.

b. Prior to conducting the test, allow a sufficient amount of water to pass through the specimen to cause all air to be expelled from the specimen. (Establish reservoir around the base with

water open to atmospheric pressure.)

c. Conduct Constant-Head Permeability test and report coefficient of permeability "k". Repeat a minimum of two additional times until two runs agree reasonably well.

d. Constant-Head Permeability:

$$k = \frac{QL}{Aht}$$

Q = quantity of water discharged (volume)
L = length of specimen
A = cross-sectional area of specimen
h = hydraulic head (height column of water above discharge)
t = elapsed time of test
k = coefficient of permeability (length/time)

Note: For very permeable material, maintain elevation of water above the sample for 3 minutes then measure Q (flow).

2203.5 Method of Measurement

A. Untreated Compacted Aggregate Base will be measured by one of the following:

1. Per square yard or tenth part thereof for the specified depth.

2. Per ton or tenth part thereof.

B. Portland Cement Concrete Drainable Base may be included in the Contract Documents as a single item or as separate items (Portland Cement and Base Aggregate) and measured by one of the following:

1. Per square yard or tenth part thereof for the specified depth.

2. Per ton or tenth part thereof.

C. Plant Mix Bituminous Drainable Base may be included in the Contract Documents as a single item or as separate items (Asphaltic Cement and Base Aggregate) and measured by one of the following:

1. Per square yard or tenth part thereof for the specified depth.

2. Per ton or tenth part thereof.

D. Pipe and Edge Underdrains will be measured per lineal foot or tenth part thereof. Pipe Underdrain and Edge Underdrain aggregate shall be subsidiary.

E. Blanket Underdrains will be measured by the actual quantities used as follows:

1. Per square yard or tenth part thereof for the specified depth.

2. Per ton or tenth part thereof.

2203.6 Basis of Payment

A. Untreated Compacted Aggregate Base will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

B. Portland Cement Concrete Drainable Base will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

C. Plant Mix Bituminous Drainable Base will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

D. Pipe and Edge Underdrains will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

E. Blanket Underdrains will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

SECTION 2204 PRIME AND TACK COAT

2204.1 Scope

This section governs the furnishing of all labor, materials and equipment for the application of liquid asphalt to a prepared pavement (concrete, asphaltic concrete), or granular base as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2204.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

ASTM
D 140 Practice for Sampling Bituminous Materials

2204.3 Materials

A. The type and grade of asphalt material to be used as prime or tack coat shall be designated by the Engineer in the Plans or in the Special Provisions. If not specified in the Plans or Special Provisions, the Contractor shall

submit proposed type and grade of asphalt material to the Engineer for approval. The liquid asphalt material to be used for surface preparation shall be as listed in the following table:

Material to be Treated	Application Usage	Type of Emulsion of Grade of Cutback	Application Rate (Gal/SY) (L/SM)	Application Temperature ^{0}F (^{0}C)	Cure Time at 70^{0}F (21^{0}C)
Existing Asphalt or Concrete Surface	Tack	RC-70	0.05-0.10 Gal/SY (0.23-0.46 L/SM)	150 – 225 (65 – 107)	1 – 6 hrs
	Tack	SS-1 SS-1h CSS-1 CSS-1h	0.05-0.15 Gal/SY (0.23-0.69 L/SM)	70 – 160 (22.5 – 42)	1 – 3 hrs
Treated Base (lime, flyash, cement)	Prime	MC-30 MC-70	0.1-0.3 Gal/SY (0.46-1.38 L/SM)	85 – 120 (29 – 49)	12 – 24 hrs
	Prime	SS-1 SS-1h CSS-1 CSS-1h	0.1-0.3 Gal/SY/in (0.46-1.38 L/SM/mm)	70 – 160 (20 – 70)	24 – 48 hrs
Untreated Aggregate Base w/ Fines	Prime	MC-30 MC-70	0.1-0.3 Gal/SY (0.46-1.38 L/SM)	85 – 120 (29 – 49)	12 – 24 hrs
Untreated Aggregate Base w/o Fines	Prime	MC-250	0.2-0.5 Gal/SY (0.92-2.30 L/SM)	85 – 120 (29 – 49)	12 – 24 hrs
Untreated Aggregate Base	Prime	SS-1 SS-1h CSS-1 CSS-1h	0.1-0.3 Gal/SY/in (0.46-1.38 L/SM/mm)	70 – 160 (20 – 70)	24 – 48 hrs
	Prime	EAP PAE, or PEP	0.1-0.3 Gal/SY (0.46-1.38 L/SM)	70 – 160 (20 – 70)	12 – 24 hrs

The asphalt material shall conform to the latest ASTM specifications for "Asphalt Cements and Liquid Asphalts." Sampling shall be in accordance with ASTM D 140.

B. Sand Cover, if used, shall be any clean granular mineral meeting the following grading requirements. When tested with laboratory sieves 100% shall pass the No. 4 (4.75 mm) sieve and not more than 2% shall pass the No. 200 (75 um) sieve. The moisture content of the sand shall not exceed 3% by weight.

C. Asphalt materials shall be approved by the Engineer prior to use in the work. The Engineer may accept a certified analysis by the material supplier laboratory when a copy of the certified analysis accompanies each shipment of asphalt to the project. The Engineer reserves the right to perform tests of the asphalt received on the job.

2204.4 Construction

A. Pressure Distributor: The distributor shall be so designed, equipped, maintained and operated that liquid

asphalt at even heat may be applied uniformly on variable widths of surface up to 15 feet at readily determined and controlled rates from 0.02 to 1.00 gallon per square yard, with uniform pressure, and with an allowable variation from any specified rate not to exceed 0.02 gallons per square yard. Distributor equipment shall include a tachometer, pressure gauges, a calibrated tank and a thermometer for measuring temperatures of tank contents. Distributors shall be equipped with a power unit for the pump, and full circulation spray bars adjustable laterally and vertically. The calibration of all distributors must be approved by the engineer, and the contractor shall furnish all equipment, material and assistance necessary if calibration is required.

B. Preparation of Existing Surface

1. For tack coats: The existing surface shall be free of dust, loose material, grease or other foreign material at the time the tack is applied. Preparation of the surface is to be performed by the contractor before the tack is applied and is subsidiary to other items in the Contract.

2. For prime coats: the surface to be primed shall be shaped to the required grade and cross section, shall be free from ruts, corrugations, segregated material or other irregularities, and shall be uniformly compacted by rolling. The surface shall be firm and slightly damp when primer is applied. Delays in priming may necessitate reprocessing or reshaping to provide a smooth compacted surface.

C. Application of Asphalt Material

1. For Tack Coats: Asphalt emulsion shall be applied uniformly with a pressure distributor at the rate specified in the Contract, or as revised by the Engineer to be within a minimum of 0.05 and a maximum of 0.15 gallons per square yard. Water may be added to the asphalt emulsion and mixed therewith in such proportion that the resulting mixture will contain no more than 50% of added water, the quantity of added water to be approved by the Engineer. The application of the resulting mixture shall be such that the original emulsion will be spread at the specified rate. The asphalt emulsion shall be heated at the time of application to a temperature in accordance with the limits provided in Sec 2204.3, or as specified in the Contract Documents. The tack shall be properly cured and the tacked surface shall be cleaned of dirt and other foreign material before the next course is placed.

   The tack coat shall be applied in such manner as to cause the least inconvenience to traffic and to permit one-way traffic without pickup or tracking of the asphalt emulsion.

2. For Prime Coats: Bituminous material shall be applied to the width of the section to be primed by means of a pressure distributor in a uniform, continuous spread. The subgrade shall be moistened before the prime is applied. The application rate shall be as specified in the Contract Documents or as approved by the Engineer between 0.1 and 0.5 gallons per square yard. The primer shall be heated at the time of application to a temperature in accordance with the limits provided in Sec 2204.3, or as specified in the Contract Documents.

   Care shall be taken that the application of bituminous material at overlap locations is not in excess of the specified quantity, per square yard. Building paper shall be placed over the end of the previous applications and the joining application shall start on the building paper. Building paper used shall be removed and satisfactorily disposed of. Pools of primer material remaining on the surface after the application shall be removed.

   When traffic is maintained, not more than one half of the width of the section shall be treated in one application and one-way traffic will be permitted on the untreated portion of the roadbed. As soon as the bituminous material has been absorbed by the surface and will not pick up, traffic shall be routed to the treated portion and the remaining width of the section will be primed.

The primer shall be properly cured, and the primed surface shall be cleaned of dirt and surplus sand before the next course is placed.

D. Application of Sand Cover: If the asphalt material is not completely cured within the maximum specified curing time, sufficient sand shall be spread over the surface with a mechanical spreader to blot up the excess asphalt. The rate of application shall be specified or approved by the Engineer. Prior to placing an asphalt paving course, all loose sand shall be swept from the primed surface.

2204.5 Method of Measurement

Asphalt Prime and Tack Coat will be measured per gallon.

2204.6 Basis of Payment

Asphalt Prime and Tack Coat will be paid for at the Contract unit bid price.

SECTION 2205 ASPHALTIC CONCRETE SURFACE AND BASE

2205.1 Scope

This section governs the furnishing of all labor, materials and equipment for the construction of asphalt concrete base and/or asphalt concrete surface as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2205.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

ASTM

C 88 Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
C 117 Test Method for Materials Finer than 75- um (No. 200) Sieve in Mineral Aggregates by Washing
C 127 Test Method for Specific Gravity and Absorption of Coarse Aggregate
C 128 Test Method for Specific Gravity and Absorption of Fine Aggregate
C 131 Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
C 136 Test Method for Sieve Analysis of Fine and Coarse Aggregates
C 142 Test Method for Clay Lumps and Friable Particles in Aggregates
D 75 Practice for Sampling Aggregates
D 140 Practice for Sampling Bituminous Materials
D 979 Practice for Sampling Bituminous Paving Mixtures
D 1188 Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
D 2041 Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures (comparable to AASHTO T209)
D 2172 Test Methods for Quantitative Extraction of Bitumen From Bituminous Paving Mixtures
D 2726 Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
D 2950 Test Method for Density of Bituminous Concrete in Place by Nuclear Methods

D 3666 Specification for Minimum Requirements for Agencies Testing and Inspecting Bituminous Paving Materials
D 4552 Practice for Classifying Hot-Mix Recycling Agents
D 4791 Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
D 5444 Test Method for Mechanical Size Analysis of Extracted Aggregate
D 6307 Test Method for Asphalt Content of Hot-Mix Asphalt by Ignition Method
D 6373 Specification for Performance Graded Asphalt Binder

AASHTO
T 166 Standard Method of Test for Bulk Specific Gravity (Gmb) of Compacted Hot Mix Asphalt (HMA) Using Saturated Surface-Dry Specimens
T 245 Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
T 269 Standard Method of Test for Percent Air Voids in Compacted Dense and Open Asphalt Mixtures (ASTM Designation: D 3203/D 3203M-11)
T 283 Resistance of Compacted Bituminous Mixture to Moisture Induced Damage
T 312 Standard Method of Test for Preparing and Determining the Density of Asphalt Mixture Specimens by Means of the Superpave Gyratory Compactor

Asphalt Institute
"Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types", MS-2, latest edition

Kansas Department of Transportation
Standard Specifications for State Road and Bridge Construction, 2015 Edition

Missouri Highways and Transportation Commission
Missouri Standard Specifications for Highway Construction, 2011 Edition

National Institute of Standards and Technology
Handbook #44, "Specifications, Tolerance and other Technical Requirements for Commercial Weighing and Measuring Devices"

2205.3 Materials

No material shall be used until it has been approved by the Engineer. All costs associated with material testing, certification and the preparation of trial mixes to determine the job mix formula shall be the responsibility of the Contractor. Representative samples of all materials proposed for use under these specifications shall be submitted by the Contractor to a properly certified testing laboratory approved by the Owner, at the Contractor's expense, for testing and the preparation of trial mixes to determine the job-mix formula. Tests required by this specification for field verification of the mix shall be the responsibility of the Contractor at the Contractor's expense, unless specified otherwise. The Engineer reserves the right to perform additional testing to verify conformance with the requirements specified herein. These tests will be performed under the supervision of the Engineer without cost to the Contractor, unless specified otherwise in the Contract Documents.

A. Asphalt: Asphalt cement used in the manufacture of asphalt paving mixtures shall conform to the Performance Graded system. The PG graded material used shall conform to the provincial grade used by the local DOT or as designated by the Engineer. In the Kansas City Metropolitan area, the provincial grade is a PG64-28 but PG 64-22 is commonly used so either is deemed acceptable.

B. These general usage guidelines may not address all project conditions. APWA strongly recommends that the Engineer apply sound pavement design principles when designating mix type and selecting asphalt cement

grade based upon individual project conditions. The Federal Highway Administration makes available LTPPBIND software that will assist with asphalt grade selection for specific projects.

The asphalt cement shall conform to ASTM D 6373. Sampling shall be in accordance with ASTM D 140.

The Contractor or asphalt supplier shall submit a temperature-viscosity chart showing the recommended mix and compaction temperatures for non-modified asphalts, and shall provide the specific gravity of the asphalt.

C. Aggregate: The quality of aggregates used in Asphaltic Concrete shall conform to the following:

Coarse Aggregate (Retained on the No. 4 Sieve)
LA Abrasion (ASTM C 131) ..... 40% loss (maximum)
Soundness using Mag. Sulfate (ASTM C 88, 5 cycles) ..... 18% loss (maximum)
Soundness using Sodium Sulfate (ASTM C 88, 5 cycles)…… ..... 12% loss (maximum)
Total shale, clay, coal and lignite content (ASTM C 142) ..... 1.0% by weight (max)

Fine Aggregate (Passing the No. 4 Sieve)
Organic content ..... 1% maximum
The parent material of manufactured sand must also meet the requirements for coarse aggregate shown above.

Sampling shall be in accordance with ASTM D 75. Gradation analysis shall be in accordance with Standard Method of Test for Material Finer than No. 200 (75 um) Sieve in Mineral Aggregates by Washing, ASTM C 117 and Standard Method Test for Sieve Analysis of Fine and Coarse Aggregate, ASTM C 136. All aggregate quality tests must have been run within 12 months of the submission date of a mix design.

D. Commercial Mix: Providing a commercial mix will only be permitted when specified in the Contract Documents or approved in writing by the Engineer. Contractor shall adhere to the most current State Department of Transportation standard specifications governing commercial mix asphalt for the state the work is being performed in. Example: for Kansas, Standard Specifications for State Road and Bridge Construction, 2015 Edition, Section 611, or for Missouri, Missouri Standard Specifications For Highway Construction, 2011 Edition, Division 400.

2205.4 Mixing and Proportioning

A. Composition of the Mix: Asphaltic concrete mixtures shall consist of Mineral Aggregates and Asphalt Cement within the following limits for the type specified.

	ASPHALTIC CONCRETE-TYPE					
	1-01	**2-01**	**3-01**	**4-01**	**5-01**	**6-01**
Percent by Weight of Total Mixture						
Asphalt Cement	4-6	4-7	4-7	5-7.5		
Aggregate - U.S. Standard						
Square Sieve Size Total Percent Passing by Weight						
1 ½" (37.5 mm)	100	--	--	--	--	--
1" (25.0 mm)	75-100	100	--	--	100	--
¾" (19.0 mm)	60-85	80-100	100	--	95-100	100
½" (12.5 mm)	--	--	85-100	100	--	86-100
3/8" (9.0 mm)	40-65	60-80	70-90	85-100	--	75-100
No. 4 (4.75 mm)	30-50	48-65	50-70	55-75	--	--
No. 8 (2.4 mm)	19-36	35-47	37-47	39-50	28 min	28 min
No. 16 (1.2 mm)	13-26	25-36	26-36	27-38	--	--
No. 30 (0.6 mm)	--	18-30	18-30	19-30	--	--
No. 50 (0.3 mm)	--	12-22	12-22	11-23	--	--
No. 100 (150 µm	4-12	6-14	6-15	6-16	--	--
No. 200 (75 µm)	2-10	3-10	4-10	4-10	2-6	2-6

In addition to the above limits, the difference between the "Percent Passing Square Mesh Sieve" of successive sieve sizes shall not exceed 25 for types 1-01, 2-01, 3-01, and 4-01.

That fraction of material retained on the No. 4 (4.75-mm) Sieve-shall be composed of particles with not less than 75% having two or more fractured faces for asphalt types 1-01, 2-01, 3-01, and 4-01, and not more than 20% by weight of that fraction shall be composed of flat or elongated particles based on a ratio of 5:1 when tested in accordance with ASTM D 4791. For Asphalt Types 5-01 and 6-01 only, the total aggregate (coarse aggregate, fine aggregate, and the material passing the No. 200 sieve (75um) shall contain not less than 85% crushed material for intermediate course and surface course.

It shall be noted that when the gradation varies appreciably from the single point gradation used in the mix design, the test properties of the mix will be out of specification. This condition can occur even though the gradation meets the tolerances below.

The job-mix formula shall be within the limits specified above. The maximum permissible variation from the job-mix formula, within the specification limits, shall be as follows:

Permissible Gradation Variation from Mix Design Percent by Wt. of Total Mix:

U.S. Standard Sieve Size	Type 1-01, 5-01, 6-01	Type 2-01, 3-01, 4-01
No. 4 and larger	5.0	4.0
No. 8, 16, 30, 50	4.0	3.0
No. 200	2.0	1.0

Permissible Oil Content Variation from Mix Design:

Type 1-01, 5-01, 6-01 – 0.5%
Type 2-01, 3-01, 4-01 – 0.3%

B. Asphalt Mix General Usage:

	Surface	Base
Arterial	5-01, 6-01	5-01
Collector	5-01, 6-01	5-01
Local/Access	5-01	5-01
Paved Trail	2-01, 3-01, 4-01, 5-01	1-01.2-01.5-01
Recreational Surface	4-01	1-01, 2-01, 5-01
Parking Lot	2-01, 3-01, 5-01	1-01, 2-01, 5-01

Generally, mix types 1-01, 2-01, 3-01 and 4-01 are composed of local materials and are appropriate for general use other than roadways. **Unless specified otherwise in the Contract, Plans or Special Provisions, only mixes 5-01 and 6-01 should be used for roadways.** The Contractor may submit a written request to use mix 1-01 for pavement base or mix 3-01 for pavement surface.

Mix type 2-01 is acceptable for surfacing, but is generally more open-graded than the other surface mixes, and may not provide a tightly sealed surface.

Mix type 4-01 is very susceptible to rutting and is only recommended for non-vehicular use.

C. Asphalt Hot-Mix Recycling

1. General: Except as modified herein, Recycled Asphaltic Concrete (RAC) shall be equal to that produced as new material. Reclaimed Asphalt Pavement (RAP), Fractionated Reclaimed Asphalt Pavement (FRAP) and/or Reclaimed Aggregate Materials (RAM) shall represent no more than 30% of the composition for all surface mixtures and no more than 40% of the composition for all base mixtures. However, for base mixtures using FRAP, the composition may be no more than 50%.

   Recycled Asphaltic Concrete may contain combinations of FRAP, RAP, RAM, coarse aggregate, fine aggregate, mineral filler, asphalt cement, recycling agent, anti-stripping agent and approved additives to produce an acceptable mixture. Recycled Asphalt Shingles (RAS) are not allowed. Recycled Asphaltic Concretes shall be designated by prefacing the type with “RC,” such as “RC Type 1-01”.

2. FRAP is defined as having two or more stockpiles, where RAP is processed into coarse and fine fractions. The fine FRAP stockpile will contain only material passing the ¼ inch screen. The coarse FRAP stockpile will contain milled material retained on the ¼ inch screen and passing the ¾ inch screen. FRAP may be comprised of coarse or fine FRAP or a combination thereof. Utilize a separate cold feed bin for each stockpile of FRAP used. Do not blend coarse and fine FRAP either in the stockpile or in a cold feed bin. Add FRAP to the mix through the RAP collar. Sources and types FRAP must be recorded and submitted to the Engineer upon request. The FRAP used in production shall be similar in composition (extracted gradation and asphalt content) to the source used for design.

3. Materials Evaluation: All recycled materials shall have the following tests performed in addition to those required in Section 2205.4.D:

   a. A sieve analysis shall be performed on FRAP, RAP and/or RAM in accordance with ASTM C 117, "Standard Test Method for Material Finer than No. 200 Sieve (75 um) in Mineral Aggregates by Washing" and ASTM C 136, "Standard Method for Sieve Analysis of Fine and Coarse Aggregates" after extraction of asphalt.
   b. Asphalt content analysis shall be performed for FRAP or RAP in accordance with Method "A" of ASTM D 2172, "Standard Test Methods for Quantitative Extraction of Bitumen from Bituminous Paving Mixtures" where the FRAP or RAP content exceeds 30%. For mixtures

with FRAP or RAP contents less than 30%, asphalt content may be determined using ASTM D 6307.

c. The asphalt cement used shall be determined as follows:
   i. For FRAP or RAP contents of up to 20%, the asphalt grade shall be as specified in the mix design.
   ii. For FRAP or RAP contents from 20% up to 30%, the asphalt grade shall be decreased one temperature range. For example, a design PG 64-22 would be decreased to a PG 58-28.
   iii. For FRAP or RAP contents from 30% to 50%, the asphalt grade of the new asphalt shall be determined using the procedures outlined in MS-2, latest edition, Appendix A. This would likely result in a PG 52-34.

d. All sources of material for use in RAC must be approved by the Engineer prior to use.

4. Material Requirements

   a. New asphalt cements added to the aged asphalt shall meet the requirements of Section 2205.3.
   b. Recycling Agents, if used, shall meet the requirements of ASTM D 4552, "Standard Practice for Classifying Hot Mix Recycling Agents".
   c. The FRAP, RAP and/or RAM stockpiled at the plant site shall be maintained in stockpiles separated into surface and base. The RAP and/or RAM shall be processed such that 100% will pass the 1-1/2 inch (38 mm) sieve and 90% will pass the 1-inch (25.4 mm) sieve.
   d. The final product shall be free of foreign matter (e.g., old planer teeth, ice, wood, soil, broken sewer castings, loop detector wire, protective membranes, rubberized joint filler materials and foil turn lane markers, trash, debris, etc.).

5. Mix Design Requirements: The necessary steps for a final mix design for recycled mixtures shall be done in accordance with the Asphalt Institute's Manual MS-2 latest edition in the appendix entitled "Mix Design Using RAP". If there is a change in the RAP and/or RAM percentage from the original amount of RAP and/or RAM in the mix design, a new mix design must be submitted.

6. Asphalt Plant Requirements: All delivery tickets shall designate the type of recycled mix, (RC-Type 1-01, RC-Type 2-01, RC-Type 3-01, etc.).

D. Mix Design Criteria: Laboratory Test Specimen(s) of mixes 1-01, 2-01, 3-01 and 4-01, combined in proportions of the job-mix formula, shall be prepared and tested in accordance with AASHTO T 245 and the volumetric properties of the compacted paving mixtures as calculated by ASTM procedures using Chapter 4 of the Mix Design Methods for Asphalt Concrete and other Hot-Mix Types (MS-2), latest edition, Asphalt Institute referred hereafter as “MS-2”. The Marshall procedure shall be as specified in Chapter 5 of the MS-2.

For mixes 5-01 and 6-01, the procedures outlined in Asphalt Institute’s “Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types (MS-2)”, latest edition, must be used to prepare the asphalt samples for design and quality control testing. The gyratory values for the SuperGyratory Compactor (SGC) to be used for this purpose are $N_{initial}$ = 6, N_{design} = 50, and N_{max} = 75. At $N_{initial}$, the specific gravity of the specimen must be 90.5% or less of G_{mm}, at N_{max} the specific gravity of the specimen must be 98.0% or less of G_{mm}. The Voids in the Mineral Aggregate (VMA) shall be as specified in Chapter 5 of the MS-2.

The material for the theoretical specific gravity (G_{mm} per ASTM D 2041) and the material for the Marshall specimens and Super Gyratory Compactor specimens (pucks) shall be cured at 285+/-5ºF for four hours in a closed oven after the mix is produced in the laboratory. Also, the plant produced mixture shall be tested when the mix is four hours old when preparing a mix design but may be tested when at least two hours old for

production testing. The mixture shall be transported to the laboratory in an insulated container and then stored in a laboratory oven at 285 +/-5°F for the remainder of the curing period. This procedure shall be used when the water-absorption as determined by ASTM C 127 and ASTM C 128 of any aggregate in the mixture exceeds 1.25%. The mixture shall be compacted at 285 +/-5°F. If total mix aggregate absorption exceeds 2.0%, the laboratory may use the G_{mm} dryback option within the test method.

Test requirements and criteria for the paving mixes under these specifications shall be as follows:

Marshall Stability: 1500 lbs. (6672 N) minimum (Types 1-01, 2-01, 3-01, and 4-01)

No. of compaction blows: 50 (Types 1-01, 2-01, 3-01, and 4-01)

Flow: 0.08-0.16 inches maximum (Types 1-01, 2-01, 3-01, and 4-01)

Air Voids:	Percent
Base & Surface (Types 5-01 & 6-01)	3-5
Base & Surface (Types 1-01, 2-01, 3-01, and 4-01)	2-5

Voids filled with asphalt (VFA)	Percent
Types 5-01 & 6-01	65-75

Voids in Mineral Aggregate (VMA) for Types 5-01 & 6-01

(Nominal Max Size as defined in MS-2)	Percent (min.)
3/4" (19 mm)	13
1/2" (12.5 mm)	14
3/8" (9.5 mm)	15

The VMA for Mix Types 5-01 & 6-01 shall be the minimum value allowed. For these mixes, the asphalt content should be just to the left side of the low point on the VMA vs. Asphalt Percent curve, not to the "wet" or right (increasing) side of the curve. Nominal maximum sized as defined in MS-2 means the sieve size where the next smaller sieve size (from Table in Section 2205.4.A) retains at least 10% of the sample.

The VMA requirements shown represent values that may be higher than those obtained in the KC Metropolitan area using locally available materials. The minimum values are values recommended by the Asphalt Institute in MS-2, latest edition, for high quality asphaltic concretes, but may require the use of non-local aggregates. VMA values shown are for 4% air voids and should be used for the design of conventional roadway pavements.

During production, the air voids can be expected to vary plus or minus 1% of the design value of 4%. For Mix Types 1-01, 2-01, 3-01, and 4-01, 3% - 4% air voids may be used for design and production may be allowed to vary plus or minus 1% of the design value.

The ratio of minus 200 (75 um) material to % Effective asphalt cement (P_{eff}) based on the weight of the aggregate shall be between 0.6-1.4 for Mix Types 5-01 and 6-01.

The blend of FRAP, RAP and/or RAM and virgin aggregates or non-recycled asphalts shall be checked for resistance to stripping using AASHTO T 283 to determine if an anti-stripping agent is needed. The index of retained strength shall exceed 75% for Mix Types 1-01, 2-01, 3-01, and 4-01, and 80% for Mix Types 5-01 and 6-01.

E. Sampling and Testing of the Mixture: All Mix Types shall be sampled in accordance with ASTM D 979 and tested in accordance with AASHTO T 245, ASTM C 136, ASTM C 117, AASHTO T 312, AASHTO T 269,

AASHTO T 166, AASHTO T 283, ASTM D 2041, ASTM D 2726, ASTM D 1188, ASTM D 2950, ASTM C 127 and ASTM C 128, as specified herein. The mixtures will be tested for binder content in accordance with ASTM D 2172 or D 6307. The recovered aggregate will be sieved in accordance with ASTM D 5444.

F. Mixture Temperature Requirements: The temperature of the completed mix at the plant and at the paver shall be set by the Contractor/Producer who shall consider hauling and placing conditions, asphalt specifications as set forth in Section 2205.3, and weather limitations set forth in Section 2205.9.B. The temperature of Mix Types 5-01 and 6-01 shall not exceed 315° F at the point of discharge from the asphalt plant.

When the mix is produced in a batch-type plant, the aggregate shall be weighed accurately in the designated proportions to provide the specified batch weight. The temperature of the aggregate at the time of introduction into the mixer shall be determined by the Contractor/Producer, with a tolerance of + or - 25º F. In no case, however, shall the temperature of the mixture exceed the maximum temperature recommended by the manufacturer or supplier of the asphaltic cement (generally 350º F).

G. Control of Mixing Time: The Contractor/Producer shall control mixing time to produce asphaltic concrete that is uniformly and thoroughly coated with asphaltic cement.

H. Preparation of Asphalt Cement: The asphalt shall be heated so that it can be distributed uniformly throughout the mix. For mixing applications, the specified temperature generally will be such that the asphalt viscosity is within the range of 150-190 centistokes and shall not exceed 350º F. The material shall be sufficiently fluid to produce a complete coating on every particle of aggregate within the specified mixing time.

The Contractor/Producer shall maintain calibrated temperature monitoring equipment at the point of discharge from the asphalt plant and at the asphalt tank, and shall supply temperature records upon request.

I. Preparation and Handling of Aggregate: Coarse and fine aggregate shall be stored at the plant in such a manner that the separate sizes will not become intermixed. Cold aggregates shall be carefully fed to the plant in such proportions that surpluses and shortages in the bins will not cause breaks in the continuous operation. When loading aggregate into stockpiles, and into cars, barges, and trucks, the material shall be placed in such a manner as to prevent segregation of aggregate sizes. Stockpiles shall be built in uniform layers not exceeding 5 feet in depth.

1. Samples of coarse and fine aggregate shall be submitted to the Engineer for testing upon request. The Contractor/Producer shall be responsible for the preparation and handling of aggregates to insure that the cold-feed gradations fall within the mix design limits. Cold-feed gradation tests shall be taken as requested by the Engineer.

2. Drying: The aggregate shall be thoroughly dried and heated to provide a paving mix temperature within a tolerance of + or – 25º F of that specified by the approved mix design. The moisture content of the heated and dried aggregate shall not exceed 0.5%. The quantity of material fed through the dryer shall in all cases be held to an amount which can be thoroughly dried and heated.

J. Inspection and Control of Asphalt Mixing Plant

1. Tests: During production the plant shall have the specified tests performed by an approved laboratory. These may include: asphalt (binder) content, aggregate gradation after removal of asphalt, density, stability, % voids, VMA, VFA, theoretical specific gravity, bulk specific gravity, maximum theoretical density, maximum theoretical specific gravity, tensile strength ratio, etc. Properties of the plant produced mix shall be determined using uncompacted mix sampled behind the paver. Laboratories shall be approved if they are:

a. Accredited in accordance with ASTM D3666; and/or
b. Approved for Superpave asphalt testing by the State Highway Department in the state where the plant is located.
    i. The individual performing the test must carry a state certification for Superpave testing.
    ii. The laboratory must have an annual certification by an independent testing agency of all testing equipment used for Superpave mix designs, and must also have the Marshall hammer weight and height of drop certified by that same agency.

2. Availability of test reports: The results of the latest current test report shall be furnished to the Engineer upon request. All test reports shall be kept at the plant, and shall be made available upon request. If the mix is found to be outside of tolerance, or outside the specification limits as specified in Section 2205.4, correction shall be made. Test reports shall be furnished on the appropriate attached "Asphalt Concrete Test" form or a similar form containing equivalent information.

3. Frequency of testing for mixes 1-01 through 4-01: the tests listed in paragraph 1 shall be performed a minimum of once for every 3000 tons of asphalt production (minimum of once per day when the plant has produced at least 200 tons and at discretion of Engineer if less than 200 tons produced) except during initial startup, or whenever the production asphalt fails one of the following conditions at which time they will be tested every 1000 tons until 4 consecutive tests show compliance with the specifications:

    a. Production void content measured at the plant discharge is less than 2% or more than 5%.
    b. Extracted gradation of the production asphalt exceeds the permissible gradation variation for the mix type being produced.
    c. Asphalt cement exceeds the content variation for the mix type being produced.

4. Frequency of testing for mixes 5-01 and 6-01: the tests listed in paragraph 1 shall be performed once per day of production, or every 1000 tons, whichever is less frequent except during initial startup (if less than 200 tons produced testing is at discretion of Engineer); or whenever the production fails one of the following conditions at which time they will be tested every 500 tons, or twice per day of production, whichever is less frequent until 4 consecutive tests show compliance with the specifications:

    a. Production void content measured at the plant discharge is less than 3% or more than 5%.
    b. Extracted gradation of the production asphalt exceeds the permissible gradation variation for the mix type being produced.
    c. Production VMA measured at the plant discharge is below the design minimum VMA.
    d. Production VFA measured at the plant discharge is outside the allowable range.
    e. Production dust to binder ratio is outside the allowable range.

5. Redesign of Asphalt mixes: If four consecutive tests performed as described in paragraph 3 or 4 above show noncompliance with the specifications as enumerated in the subparagraphs of paragraph 3 or 4 above, production of that type of asphalt will immediately cease, and may not be resumed until a new mix design is submitted and approved, or the plant can demonstrate to the Engineer an ability to meet specifications. Resumption of asphalt production after a mix redesign or failure of four consecutive tests to meet specifications will be treated as an initial startup for testing purposes.

MARSHALL ASPHALTIC CONCRETE TEST (Verified Mix Design)
(Types 1-01, 2-01, 3-01, 4-01)

Description:				
APWA Type:				
LAB ID:		LOT		
Sample Date:		Belt		Tons
Sample ID:		Hot Mix		Tons
Supplier:				

Sieve Size	Belt Sample	Hot-Mix Sample*	Single Point Job-Mix Formula	Job-Mix Formula Tolerances
1" (25 mm)				
3/4" (19 mm)				
1/2" (12.5 mm)				
3/8" (9.5 mm)				
No. 4 (4.75 mm)				
No. 8 (2.36 mm)				
No. 16 (1.18 mm)				
No. 30 (600 um)				
No. 50 (300 um)				
No. 100 (150 um)				
No. 200 (75 um)				

ASTM C 136, C 117, D 5444

*Uncompacted Behind Paver
**total mix basis
***total aggregate

EXTRACTION DATA - ASTM D6307 or D 2172	FRAP	Sample	Plant Setting	Recycled AC%
%AC**				
%AC**				

Aggregate Type	%***	Aggregate Type	%***

MARSHALL CHARACTERISTICS (ACCEPTANCE CRITERIA)			
Compaction Blows (average of 3 specimens) = 50			
	Sample*	Specifications*	
Stability, lbs (kg)		Min	AASHTO T 245
Flow, 1/100 in (mm)		Max	AASHTO T 245
% Voids		3-5	
% VFA			
Density, pcf (kg/cu.m)		-----	ASTM D 2950, D 2726, or D 1188
Max Theoretical Specific Gravity G_{mm}		-----	ASTM D 2041
Bulk Spec. Gr. of total Agg. Gsb		-----	ASTM C 127 & C 128
COMMENTS:			

LOT DENSITY SHALL BE TIED TO THE LOT AND DATE (Laboratories shall conform to ASTM D 3666)

SUPERPAVE ASPHALTIC CONCRETE TEST (Verified Mix Design)
(Types 5-01, 6-01)

Description:				
APWA Type:				
LAB ID:			TIME	TONS
Sample Date:		Belt		
Sample ID:		Hot Mix		
Supplier:				

Sieve Size	Belt Sample	FRAP/RAP Sample*	Hot-Mix Sample*	Master Grade Limits	Cal. Single Point
1" (25 mm)					
3/4" (19 mm)					
1/2" (12.5 mm)					
3/8" (9.5 mm)					
No. 4 (4.75 mm)					
No. 8 (2.36 mm)					
No. 16 (1.18 mm)					
No. 30 (600 um)					
No. 50 (300 um)					
No. 100 (150 um)					
No. 200 (75 um)					

ASTM C 136, C 117, D 5444

*Uncompacted Behind Paver
**total mix basis
***total aggregate

EXTRACTION DATA - ASTM D6307 or D 2172	FRAP	Sample	Plant Setting	Recycled AC%
%AC**				
%AC**				

Aggregate Type	%***	Aggregate Type	%***

VOLUMETRIC DATA 6" NOMINAL SIZE Gyratory Specimens			
Gyrations (avg. of 2 specimens) @ 280-290 deg F – AASHTO T312 N_{des} = 50 N_{ini} = 6 N_{max} = 75	Sample*	Specifications*	
Mix bulk specific gravity @ N_{des}, G_{mb}		---	
% Voids @ N_{des}		3.0-5.0	AASHTO T 269
% VMA @N_{des}, G_{sb} basis			
% VFA @ Ndes		9.0–11.0	=%VMA-%Voids
% G_{mm} @ Nini		85-91	AASHTO T 166
Ratio (-) 75 um (No. 200) to % Eff. Binder		0.6-1.4	
Tensile Strength Ratio, %		80 minimum	AASHTO T 283
Max Theoretical Specific Gravity G_{mm}		-----	ASTM D 2041
Max Theoretical Density, pcf		-----	
Effective Specific Gravity Agg., G_{se}		-----	
Bulk Specific Gravity of Total Agg., G_{sb}		-----	ASTM C 127 & C 128
Specific Gravity of Asphalt, G_b		-----	
COMMENTS:			

2205.5 Asphalt Mixing Plant

Plants used by the Contractor for preparation of the asphalt paving mix shall conform to the following requirements:

A. Field Testing Laboratory: The Contractor shall provide a laboratory building or room at the plant site, for the exclusive use of the Engineer for performing tests, keeping records, and making reports at such times as the Engineer is performing those actions.

The Contractor shall also furnish necessary laboratory sieves and a powered shaker device for sieve analysis, scales, ignition oven and supplementary equipment to make aggregate sieve analysis, asphaltic concrete paving mixture analysis, and paving mixture density tests. This equipment shall be in good working condition and properly calibrated.

B. The asphalt producer shall establish a quality control plan and shall maintain records. The quality control plan required by the state highway agency is a suggested standard. Upon request by the Engineer, the quality control plan shall be submitted for review and approval.

2205.6 Transportation of Mix

The mix shall be transported to the job site in vehicles with tight metal bottoms, clean of all foreign material which may affect the mix. If a release agent is used, it must comply with State and Federal environmental regulations.

The dispatching of the vehicles shall be so scheduled that all materials delivered may be placed in daylight unless the Engineer approves artificial light. Delivery of the material to the paver shall be at a uniform rate and in an amount within the capacity of the paving and compacting equipment.

Haul trucks shall be provided with covers of sufficient size and weight to completely cover the truck bed to protect the load and to prevent cooling of the upper surface. Failure to have the load completely covered shall be sufficient cause for rejection of the entire load. The load shall remain covered until the truck is next in line to be unloaded. In no case shall a load remain uncovered for more than 10 minutes before starting to use the load. If for any reason there is a delay in completely using a load, the remaining part of the load shall be recovered until it can be used. It shall be the responsibility of the Contractor to inform all truck drivers of these provisions before starting work.

2205.7 Scales and Weighing of Vehicles

The vehicle's tare and gross weight shall be established by weighing the vehicle on a certified scale. The tare weight will be established at least twice each day. The vehicle, when establishing tare, shall be clean, bed empty, fuel tanks filled and shall have all side and back boards in place.

A. Measurement by weight: Measurement will be made by weighing each truck load on scales conforming to the requirements of Section 2205.7.B “Vehicle Scales”.

B. Vehicle Scales: Vehicle scales shall be approved by the Engineer and shall conform to the requirements specified herein. The specifications, tolerances, and other technical requirements for weighing and measuring devices as recommended by the National Conference on Weights and Measures and published in the National Institute of Standards and Technology Handbook 44, Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices, and supplements thereto or revisions thereof, shall apply to all vehicles scales used.

C. Scale acceptance shall be based on one of the following:

1. A valid certification or seal of approval by the Division of Weights and Measures from the state.

2. A certification of calibration from a commercial scale service company showing that the scale meets the requirements of these specifications. The Contractor shall furnish the certification of calibration to the Engineer.

D. Scale Calibration: Scales shall have been calibrated within the nine month period prior to any material being delivered, or at any time the Engineer has cause to question the accuracy of the scale. Scales shall meet the requirements of Accuracy Class III L as defined in Handbook 44 (above).

Verification of a vehicle scale may be required by weighing a hauling unit on another recently calibrated and certified scale.

If equipment to be weighed is of such length that all axles cannot be weighed simultaneously, a level paved surface shall be provided permitting those axles not on the scale platform to be supported by the paved surface. The approach shall be at least as wide as the platform and of sufficient length to insure the level positioning of vehicles during weight determinations. The weighing shall be performed with all brakes released. If equipment to be weighed is equipped with an air bag suspension unit on any axle, the equipment including semi-trailers or pup trailers shall be weighed on vehicle scales of sufficient size to weigh all axles of the combination simultaneously.

All costs incurred in obtaining a certification of calibration or verification shall be borne by the Contractor.

2205.8 Asphalt Paving Equipment

All asphalt paving equipment used by the Contractor shall meet the requirements of this section and shall be maintained in acceptable mechanical condition. Equipment shall be serviced and lubricated away from the paving site. Units that drip fuel, oil, grease or other fluids shall be removed from the project until such leakage is corrected.

A. Pavers and Laydown Machines: Mechanical self-powered pavers shall be capable of spreading the mix within the specified tolerances, true to the line, grade and crown indicated on the Plans.

Pavers shall be in good working condition, equipped with quick and efficient steering devices and shall be capable of traveling both forward and in reverse. They shall be equipped with hoppers and distributing screws that place the mix evenly in front of the adjustable screeds. They shall be equipped with either a vibrating screed or a tamping bar immediately preceding a static screed. There shall be sufficient auxiliary attachments for the paving machine so that it may be operated to lay the necessary width as determined in the field by the Engineer. Vibrating screed or tamp bars shall be provided for the full width of all paving operations.

The screed shall include a strike-off device which is effective on mixes at workable temperatures without tearing, shoving or gouging them, and which produces a finished surface of an even and uniform texture. The screed shall be adjustable as to the height and crown and shall be equipped with a controlled heating device for use when required. However, for irregular width paving, hydraulic extensions without tamping bars or a vibrating screed may be used only along the curb or outer edge of pavement.

1. Automatic Screed Controls: The paver shall be equipped with and use an approved system capable of automatically controlling the elevation and transverse slope of the paver screed unless otherwise directed by the Engineer. An erected stringline, traveling stringline or other approved device operating on the roadbed being paved or the surface of the previously placed lane shall be used to establish the grade reference. The grade reference device shall operate on either or both sides of the paver as

required and shall be capable of maintaining the desired transverse slope regardless of changes in the screed elevation.

2. The traveling stringline shall be constructed in such a manner that it does not vibrate or cause the sensor to make erroneous readings during the laydown operation. The length of the beam to be used shall be approved by the Engineer and shall be between 20 feet and 40 feet.

3. The use of the automatic screed control devices on asphalt pavers will not be required for paving small irregular areas, entrances, approaches, or side street connections.

4. Automatic screed control devices will be required for matching the joint with all previously laid strips, except for those areas noted above.

B. Rollers: Compaction equipment shall consist of vibratory steel wheel, static steel wheel and pneumatic-tired rollers unless otherwise directed by the Engineer. They shall be self-propelled and equipped with such controls that starting, stopping and reversing direction can be accomplished without displacing the hot asphaltic concrete pavement.

Rollers shall be equipped with adjustable scrapers to keep the wheel surfaces clean and with efficient means of keeping them wet to prevent mixes from sticking. The roller surfaces shall have no flat areas, openings or projections that will mar the surface of the pavement.

1. Steel-Wheeled Rollers: Steel-Wheeled Rollers shall be self-propelled, vibratory two-axle tandem rollers. These rollers shall develop contact pressure of 250 to 350 pounds per inch of width (vibratory mode) or 150 to 180 pounds per inch of width (static). Rollers shall be in good working condition.

2. Pneumatic-Tired Rollers: Heavy pneumatic-tired rollers shall be self-propelled and shall consist of two axles on which are mounted an odd number of pneumatic-tired wheels. The roller shall have at least nine pneumatic-tired wheels mounted in such a manner that the rear group of wheels will not follow in the tracks of the forward group, but shall be spaced to give essentially uniform coverage with each pass. Axles shall be mounted in a rigid frame provided with a loading platform or body suitable for ballast loading. Tires shall be smooth, inflated to 90 psi. Construction of the roller shall be such that each wheel is loaded to a minimum of 2,300 pounds.

3. In lieu of the above requirements, consideration will be given to use other types of equipment that are capable of producing equivalent results consistent with the requirements of the specifications. Any roller not meeting the requirements of paragraphs 1 and 2 above must be approved by the Engineer prior to use.

C. Pressure Distributor: The pressure distributor shall meet the requirements of Section 2204.4.A entitled "Pressure Distributor".

D. Hand Tools: The Contractor shall provide sufficient lutes, rakes, shovels, and other equipment as required to produce results consistent with the specifications.

2205.9 Construction

A. Preparation of the Area to be Paved: The area to be paved shall be true to line and grade, and shall have a properly prepared surface prior to the start of the paving operations. It shall be free from all loose or foreign material.

Where a base is rough or uneven, a leveling course shall be placed and properly compacted before the placing of subsequent courses.

When leveling course is not required, depressions and other irregularities shall be patched or corrected, and the work approved by the Engineer before the paving operation begins.

The area to be paved shall be primed or tacked uniformly in accordance with the provisions of Section 2204 entitled "Prime and Tack Coat".

The surfaces of curbs, gutters, vertical faces of existing pavements and all structures in actual contact with asphalt mixes shall be painted with a thin, complete coating of tack to provide a closely bonded joint.

B. Weather Limitations: When the moisture of the aggregate in the stockpile or from the dryer interferes with the quality of mix production, or with normal plant operations, the mixing and placing of hot-mix asphalt will not be permitted without the permission of the Engineer. No mixture shall be placed on wet or frozen surface.

Hot Mix asphalt paving shall not be mixed or placed when the ambient air or base temperature is below the temperatures shown in the following table, or when there is frost in the subgrade or any other time when weather conditions are unsuitable for the type of material being placed without expressed approval of the Engineer.

Paving Course	Thickness (inches)	Air Temperature (Degrees F)	Road Surface Temperature (Degrees F)
Surface	All	50	55
Base	Less than 3	40	45
Base	3 or more	30	35

All bituminous mixtures shall be delivered to the paver at a temperature sufficient to allow the material to be placed and compacted to the specified density and surface tolerance. Minimum allowable temperature for the asphalt mix to be placed into the paver is 235º F. Regardless of the temperature, final acceptance of the asphalt mat shall be based on density determined in accordance with Section 2205.9.E.

C. Spreading and Finishing: The spreading and finishing of each course shall be to the thickness, cross slope, and width indicated on the Plans or Special Provisions. The thickness of individual layers shall not exceed the following for the respective type of mixture. The suggested minimum lift thickness shall be three times the nominal maximum size of the mix. Nominal maximum is defined as the first sieve size larger than the sieve which retains at least 10% of the aggregate by weight.

Asphalt Type	**Max. Compacted Lift Thickness**
Type 1-01	4"
Type 2-01	4"
Type 3-01	3"
Type 4-01	2"
Type 5-01	4”
Type 6-01	3”

Spreading and finishing shall be conducted in the following manner:

1. Mechanical Pavers: The base and surface courses shall be spread and struck-off with a mechanical paving machine meeting the requirements of Section 2205.8.A entitled "Pavers and Laydown

Machines". The paving machine shall be operated so that the material does not accumulate and remain along the sides of the receiving hopper. The wings of the spreader hopper shall not be emptied (flipped) between truck loads.

a. Equipment which leaves tracks or indented areas which cannot be corrected in normal operation, or which produces other permanent blemishes or fails to produce a satisfactory surface, shall not be used.
b. The screed auger shall be operated approximately 3/4 full and the hopper conveyor shall not be allowed to run out of material during the paving operation. Sufficient trucks shall be used to continuously supply asphalt to the paver. Delays in the paving operation shall be kept to a minimum.
c. When using pavers in echelon, the second paver shall follow the edge of the material placed by the first paver. The length of each laydown pass shall be limited, depending on weather conditions, to assure a hot joint and obtain proper compaction.

2. Longitudinal joints and edges shall be constructed to true lines. Lines for the paver to follow in placing individual lanes will be established parallel to the centerline of the proposed roadway. The paver shall be positioned; and operated to follow closely the established line. Offset the longitudinal joint in successive courses by 6 to 12 inches. Longitudinal joints in the final surface layer shall be at the lane lines of the traveled way, but shall be offset to prevent lane separation pavement markings from falling on the joint. Any irregularities in alignment left by the paver shall be corrected directly behind the paver, prior to compaction. Distortion of the pavement during this operation shall be avoided. Edges against which additional pavement is to be placed shall be placed on a 30º (2:1) bevel, or as specified by the Engineer.

3. Transverse joints in succeeding courses shall be offset at least 2 feet.

4. The Contractor shall make every effort to minimize the number of passes heavy equipment makes over uncompleted roadway sections. The Contractor shall schedule and route his hauling operation to minimize hauling over a final course as much as feasible.

5. As soon as the first load of material has been spread, the texture of the unrolled surface shall be checked to determine its uniformity. Segregation of materials shall not be permitted. If segregation occurs, the spreading operation shall be immediately suspended until the cause is determined and corrected by the Contractor.

6. Any irregularities in the surface of the pavement course shall be corrected directly behind the paver. Excess material forming high spots shall be removed by a shovel or lute. Indented areas shall be filled with hot mix and smoothed. Broadcasting of material shall not be permitted.

7. Hand Spreading: In small areas where the use of mechanical finishing equipment is not practical, the mix may be spread and finished by hand. The material shall be distributed uniformly to avoid segregation of the coarse and fine aggregate. Broadcasting of material shall not be permitted. During the spreading operation, all material shall be thoroughly and uniformly distributed by lutes or rakes. Material that has formed into lumps and does not break down readily shall be removed. Following placing and before rolling, the surface shall be checked with templates and straightedges and all irregularities corrected.

D. Compaction

1. General: The Contractor is responsible for development of a compaction procedure that will obtain the

required density. A minimum of three rollers shall be used for compacting mixes on roadways (2 steel drum and 1 pneumatic tire) unless otherwise approved by the Engineer. For uses other than roadways, a minimum of two rollers shall be used unless otherwise approved by the Engineer. Rollers shall meet the requirements of Section 2205.8.B entitled "Rollers".

Immediately after spreading, each course of the pavement mixture shall be uniformly compacted by rolling. The initial or "breakdown" rolling shall be accomplished with a steel-wheeled vibratory roller and shall take place as closely behind the laydown machine as the temperature and condition of the mat will allow. The pneumatic-tired roller shall be used to knead and compact the pavement mixture following the initial rolling and preceding the final rolling. Care shall be exercised in the use of the pneumatic-tired roller to ensure that the pavement mixture is sufficiently cooled to avoid "picking up" of the mixture on the tires of the roller, and also to ensure that the pneumatic-tired rolling is completed before the mixture becomes too cool to allow satisfactory finish rolling. Final, or finish rolling, shall be done with a steel-wheeled roller in static mode. The sequence of rolling operations may be changed with the approval of the Engineer. Rolling shall be longitudinal, starting near the low or unconfined edge of the pavement, then to the other edge and finally progressing towards the center. Alternate trips of the roller shall be of slightly different lengths.

The motion of the roller shall be slow enough at all times to avoid displacement of the hot mixture (generally 3mph). Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected immediately by the use of rakes and fresh mixture when required. To prevent adhesion of the mixture to the roller, the wheels shall be kept properly moistened, but excess water will not be permitted.

The surface of the mixture after compaction shall be smooth and true to established section and grade. Any surface which is segregated, or is in any way defective, shall be removed and replaced with fresh hot mixture at the Contractor's expense, and shall be immediately compacted to conform to the surrounding area.

2. Rolling Procedure: The Contractor is responsible for determining an acceptable rolling procedure that will provide a product that is uniformly compacted to the required density and true to line and grade. There are many possible variations that may accomplish this but the general order for rolling is:

   a. Transverse joint
   b. Longitudinal joint (if in echelon)
   c. Unconfined or low side edge
   d. Other edge
   e. Middle
   f. Intermediate rolling; same procedure as breakdown rolling but pneumatic roller should stay the thickness of the lift from the free edge
   g. Finish rolling

   When paving in echelon, 2-3 inches of the first mat shall be left unrolled, and rolled when the joint between the lanes is rolled, after the 2nd mat is placed. Edges shall not be exposed more than fifteen minutes without being rolled. Particular attention shall be given to the construction of transverse and longitudinal joints in all courses.

   In laying a surface mix adjacent to any finished area, it shall be placed sufficiently high so that, when compacted, the finished surface will be true and uniform. Where the grade is slight a level will be used to insure drainage to the desired outlet.

3. Transverse joints: The Contractor shall use a method of making a transverse construction joint that provides a thorough and continuous bond with acceptable surface texture and meeting the density requirements. The surface elevation should not vary more than 3/16" in 10' when tested across the joint. If the joint has been distorted, it shall be trimmed to a line. The joint face shall be tacked before the fresh material is placed against it.

4. Longitudinal joints: When paving against existing asphalt pavement, the edge to be joined shall be tack coated. The paver screed shall be set to overlap the first mat by 1-2 inches. The elevation of the screed above the surface of the first mat should be equal to the amount of roll-down expected during compaction of the new mat. For large aggregate mixes, the coarse aggregate in the material overlapping the cold joint should be carefully removed and wasted, leaving only the finer portion of the mixture. The overlapping material should be pushed with a lute or rake onto the side of the joint where the new pavement is located prior to compaction.

   When paving against existing concrete pavement, curb and gutter or other structure, the edge to be joined shall be tack coated. The elevation of the screed above the surface of the first mat should be equal to the amount of roll-down expected during compaction of the new mat. Where drainage of stormwater will flow from the new mat onto abutting curb and gutter, add an additional ⅛" - ¼" of thickness to the new mat.

5. Breakdown Rolling: Steel wheel rollers as specified in Section 2205.8.B entitled "Rollers" shall be used for breakdown rolling. Breakdown rolling shall be performed as close behind the paver as necessary to obtain adequate density without causing undue displacement. The breakdown roller shall be operated with the drive wheel nearest the laydown machine. Exceptions may be made by the Engineer when working on steep slopes or super-elevated curves. Breakdown rolling sequencing is to be determined by the Contractor and approved by the Engineer.

6. Intermediate Rolling: Pneumatic-tired rollers as specified in Section 2205.8.B entitled "Rollers" shall be used for intermediate rolling unless otherwise approved by the Engineer. The intermediate rolling shall follow the breakdown rolling as closely as possible and while the paving mix is still of a temperature that will result in maximum density from this operation. Pneumatic-tired rolling shall be continuous after the initial rolling until all of the mix placed has been compacted to the required density. Turning of pneumatic-tired rollers on the hot paving mix which causes displacement shall not be permitted.

7. Finish Rolling: The finish rolling shall be accomplished before the material falls below a temperature of 175º F to allow for the removal of roller marks. All roller marks shall be removed by the finish rolling operation. All rolling operations shall be conducted in close sequence.

8. In places inaccessible for the operation of standard rollers as specified, compaction shall be performed by others means meeting the requirements of Section 2205.8.B entitled "Rollers." The Contractor shall ensure that the material is thoroughly compacted to the satisfaction of the Engineer. If approved by the Engineer, hand tamping, manual or mechanical, may be used in such areas, if the required density is met.

E. Density and Surface Requirements: The completed asphalt concrete paving shall have a density equal to or greater than 95% for Types 1-01 and 5-01 Asphalt Concrete Base and 96% for Types 2-01, 3-01, 4-01, 5-01, and 6-01 Asphalt Concrete Surface. Density is based on the density of laboratory specimens from plant produced mix prepared as specified in Section 2205.4.D entitled "Mix Design Criteria" and made from a sample representing the material being tested. Density testing shall conform to ASTM D 2950, ASTM D 2726, or ASTM D 1188.

If cores are used to determine density, one or more tests (one test equals three cores) will be taken for each tonnage lot and averaged to determine acceptance. The cores will be taken from random locations within the lane being paved, a minimum of 1' from any joint or edge. The Engineer will mark the locations of all cores.

All unsatisfactory work shall be repaired, replaced or corrected. The surface of the final course shall be of a uniform texture and conform to line and grade shown on the Plans. Allowable tolerance for the final surface of roadway pavement shall conform to the requirements of Section 2211 entitled "Smoothness". Tests for Plan grade conformance and surface smoothness shall be performed by the Contractor in the presence of the Engineer. Tests shall be performed at intervals as directed by the Engineer.

2205.10 Method of Measurement

Asphaltic concrete base, asphaltic concrete surface, or asphaltic concrete base and surface may be included in the Contract Documents as separate items, or as a single item, and may be measured by one of the following:

A. Per square yard or tenth part thereof for the specified depth.

B. Per ton or tenth part thereof.

C. If pavement smoothness is required in the Contract, payment shall be in accordance with Section 2211.

2205.11 Basis of Payment

Asphaltic Concrete Surface, Asphaltic Concrete Base, or Asphaltic Concrete Base and Surface whether used for paving, patching, or leveling courses will be paid for by one of the following:

A. Contract unit bid price.

B. Contract lump sum bid price.

C. Testing described in Section 2205 is subsidiary to the price bid for asphalt unless otherwise provided for in the Contract.

SECTION 2206 ASPHALT CRACK SEALING, ASPHALT CRACK FILLING, CHIP SEALING, SLURRY SEALING, AND MICRO-SURFACING

2206.1 Scope

This section governs the furnishing of all labor, materials and equipment for the performance of asphalt crack sealing, asphalt crack filling, chip sealing, slurry sealing and micro-surfacing as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2206.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

ASTM

C 88 Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
C 117 Test Method for Materials Finer than 75- um (No. 200) Sieve in Mineral Aggregates by Washing
C 131 Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
C 136 Test Method for Sieve Analysis of Fine and Coarse Aggregates
C 142 Test Method for Clay Lumps and Friable Particles in AggregatesD 36 Standard Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus)
D 140 Practice for Sampling Bituminous Materials
D 242 Standard Specification for Mineral Filler For Bituminous Paving Mixtures
D 244 Standard Test Methods for Emulsified Asphalts
D 946 Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction
D 977 Standard Specification for Emulsified Asphalt
D 1073 Standard Specification for Fine Aggregate for Bituminous Paving Mixtures
D 2027 Standard Specification for Cutback Asphalt (Medium-Curing Type)
D 2028 Standard Specification for Cutback Asphalt (Rapid-Curing Type)
D 2397 Standard Specification for Cationic Emulsified Asphalt
D 2419 Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
D 3381 Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction
D 3910 Standard Practices for Design, Testing, and Construction of Slurry Seal
D 5078 Standard Specification for Crack Filler, Hot-Applied, for Asphalt Concrete and Portland Cement Concrete Pavements
D 6372 Standard Practice for Design, Testing, and Construction of Micro-Surfacing
D 6690 Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements

AASHTO

T 53 Softening Point of Bitumen (Ring-and-Ball Apparatus)
T 59 Testing Emulsified Asphalts
M 208 Standard Specification for Cationic Emulsified Asphalt

ISSA Bulletin #139 “Test Method to Classify Emulsified Asphalt/Aggregate Mixture Systems by Modified Cohesion Tester Measurement of Set and Cure Characteristics”

Manual of Uniform Traffic Control Devices, latest Edition (MUTCD)

2206.3 Crack Sealing/Filling

A. Crack Sealant Application: Material used for crack sealing shall be a modified asphalt product selected to be compatible with the environment of application and found to meet the criteria of ASTM D 6690 with a modified resilience value between 30 and 60 percent, or material meeting the requirements of ASTM D 5078. Crack Sealing shall be understood to be the process of placing an asphaltic material into and/or above working cracks to prevent the intrusion of surface water and/or incompressibles into the crack. A working crack shall be understood to correspond to cracks that sustain more than 0.1 inch of movement during the course of the year.

B. Crack Filling Application: Material used for crack filling shall be a viscosity graded AC-20 asphalt product meeting the criteria of ASTM D 3381 Table 1, a penetration-graded asphalt product having a penetration number in the range of 85-100 measured in accordance with ASTM D 946, or material meeting the criteria of ASTM D 5078. Crack filling material may contain polyester or polypropylene fibers.

C. Material satisfying the criteria of a crack sealant may also be used as a crack filling material. Crack filling shall

be understood to be the process of placing an asphaltic material into non-working cracks to substantially reduce water infiltration and reinforce adjacent cracks. Crack filling materials shall not be used for sealing pavements in preparation for an overlay.

D. Equipment

1. Router: This machine shall be an impact cutter head with a minimum of 6 tungsten-carbide cutters. The router blades shall be driven with a minimum 25-hp gasoline engine.

2. Compressor: The compressor shall be a two-stage compressor rated as a minimum 40 CFM unit capable of delivering compressed air to the nozzle at a minimum pressure of 100 psi. The compressor shall be equipped with a filter trap to eliminate oil and moisture from the air line.

3. Hot-Air Lance (HCA): The hot air lance shall be capable of delivering super-heated air at an exit temperature in excess of 1500 degrees F and at a velocity in excess of 1000 ft/sec against the side walls of the crack. The hose shall be wrapped with reflective tape to keep hoses together and to protect workers in low light situations.

4. Melter/Applicator

   a. The melting pot shall consist of double-boiler type jacket and shall be equipped with a full sweep agitator that promotes proper mixing and maintains uniform heat distribution throughout the melting pot. The melting pot shall have sufficient capacity of the heat transfer oil reservoir that heat transfer oil is able to come in contact with 100 percent of the outside area of the jacket. The melting pot shall be equipped with a drain plug to permit 100% of the heat transfer oil to drain from the boiler. The heat transfer oil shall consist of ISO grade 68.
   b. The heat transfer oil shall be heated with a properly sized vapor fuel LP or diesel fuel burner. The heat shall be applied directly to the bottom of the heat transfer tank. The burner shall be lit by an electric spark igniter controlled by a sensor, which detects a lack of burn or ignition and subsequently shuts down the fuel supply. The unit must be capable of starting at ambient temperature and bringing the sealant up to the required applications temperature within the period of approximately one hour while continuously agitating and recirculating the sealant. The unit shall have the capability of independently monitoring both the transfer oil and melting pot temperatures. The unit shall be capable of heating a variety of application materials within a range of temperatures between 200 º F and 425 º F. The sealant should not be heated to a temperature in excess of that specified by the manufacturer.
   c. The agitator and material pump shall be actuated by hydraulic motors driven by a single, pressure-compensated hydraulic pump. Hydraulic fluid should only be pumped to the agitator or material pump motor on demand.
   d. The sealant shall be applied to the pavement through an application system consisting of a pressure feed hose and wand. The hose shall be specially manufactured to handle liquid asphalt products up to 450 º F at 350 psi working pressure. The hose shall not be less than 15 feet in length. The hand wand shall be constructed of steel of sufficient strength to withstand normal day-to-day operations. Material flow through the wand shall be controlled with a toggle switch. A squeegee shall be used to distribute the asphalt evenly and uniformly in the recommended configuration.
   e. All equipment shall be in good working order, as determined by the Engineer, on a day-to-day basis. The Engineer shall not be responsible for payment of labor or rental charges on days when the equipment is not in good working order.

E. Preparation

1. Crack sealing shall be limited to working, transverse and longitudinal cracks that are more than 1/8-inch in width. Cracks 1/8- to 5/8-inches in width requiring sealing shall be routed to 5/8-inches in width. Cracks 5/8- to 1-inch in width requiring sealing do not require routing but shall be thoroughly cleaned and sealed. Cracks shall be sealed using either the Standard Reservoir and Flush or Standard Recessed Band-Aid configurations. Cracks greater than 1-inch in width shall be filled with either an emulsion slurry and sand, widened and backfilled with Hot-Mix Asphalt (HMA) in compliance with Section 2205, or repaired in a manner approved by the Engineer. Cracks requiring filling do not require any routing but simply thorough cleaning. Cracks shall be filled using either the Simple Band-Aid, Simple Flush Fill, or Capped configurations.

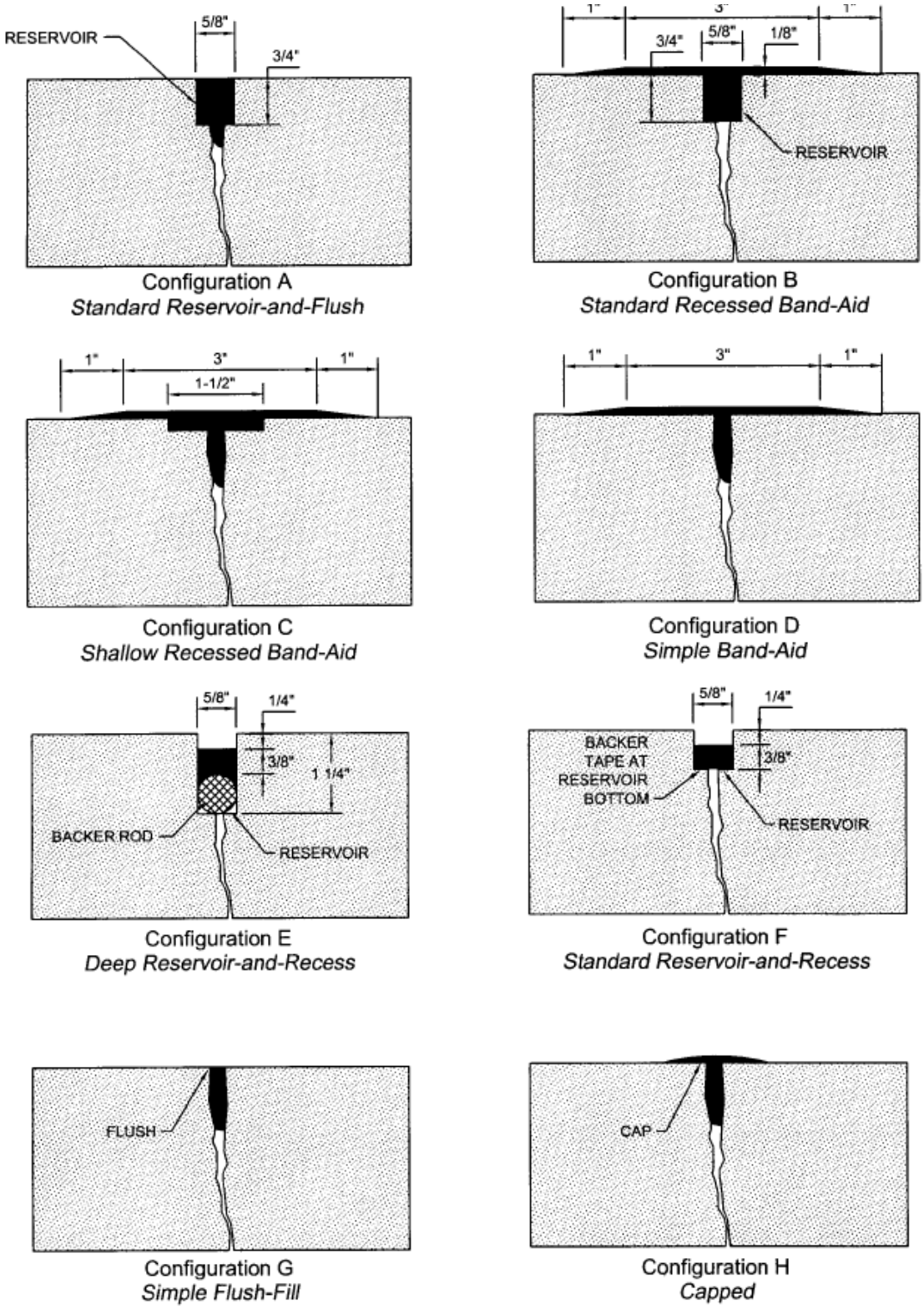
2. Cracks shall be clean and free of all deleterious materials, including any old sealant, incompressibles, and organic material. The crack shall be free of any standing water and any moisture along the sidewalls of the crack as evidenced by a darker color than the adjacent pavement. This shall be accomplished in one of three manners: wire-brushing – where the crack channels are cleaned with a mechanical wire brush followed by high-pressure compressed air; hot air blasting – where the crack channels are cleaned, heated, dried with hot compressed air (HCA) lance connected to a high pressure air compressor; or high-pressure air blasting – where the crack channels are cleaned with high-pressure compressed air. Pavement cracks to be sealed or filled shall be cleaned and dried using one of the methods described previously within 10 minutes of the application of the sealer/filler. Equipment for the two operations should be kept in a compact configuration such that not more than 50 feet separates equipment required by the two operations. Additionally, not more than 10 minutes time shall passed between the cleaning of a crack and the filling of the crack with the appropriate sealing/filling material.

F. Installation

1. Sealer/filler materials should not be applied when the pavement surface is wet or when the pavement temperature is less than 40 º F without the use of hot air blasting or the approval of the Engineer.

2. Sealant/Crack filler should be applied to fill the crack from the bottom to the top in order to prevent air bubbles from forming and creating a point of weakness in the sealant. Upon application, hot sealant/filler material should not make a hissing or popping noise indicative of moisture in the crack. Noises of this kind should indicate that additional drying of the crack is necessary in order to facilitate proper bonding of the material to the sidewalls of the crack. Application of the sealant/filler material shall be made in such a way as to completely fill the crack and provide enough excess to facilitate completion of the seal/fill consistent with the configuration selected. The use of a squeegee or applicator disk to shape the application material to conform to one of the material placement configurations shown on Figure 1 is required. Care shall be taken not to place any sealant/filler material on top of any pavement markings, manholes, or drainage castings. The Contractor shall be responsible to prevent tracking of the sealant/filler material onto the adjacent pavement surfaces to the satisfaction of the Engineer.

3. The manufacturer's technical representative shall be notified by the Contractor and shall be present during the initial installation. Prior to beginning the work, the Contractor will be required to demonstrate to the satisfaction of the Engineer and the manufacturer's representative his ability to apply the material in accordance with the manufacture's specifications. Operations and procedures which are considered by the Engineer as detrimental to the effectiveness of the material will not be permitted.



Material placement configurations for crack treatments

Figure 1

2206.4 Improved Street Chip Seal

A. Description: This work shall consist of the application of a thin, uniform layer of emulsified asphalt to the existing pavement surface in order to universally seal cracks from the intrusion of surface water. Cover aggregate shall then be uniformly distributed upon the asphalt layer and seated in place with the use of a rubber-tired roller. Any excess aggregate material shall be removed, leaving a durable wearing surface.

B. Material Requirements

1. Emulsified Asphalt

   a. The asphaltic sealant material applied to the roadway surface shall consists of a rapid-setting emulsified asphalt either an anionic RS-2 meeting the criteria of ASTM D 977 or a cationic CRS-2 meeting the criteria of ASTM D 2397. These materials may be modified with rubber products in the form of liquid latex, styrene-butidane-rubber, or styrene-butidane-styrene to enhance performance of the material as approved by the Engineer. If a polymer-modified material is used, the emulsified asphalt shall meet the additional specification criteria required by the Engineer.

   b. A sample of the emulsified asphalt may be taken from any of the distributors or delivery tankers on the job site. Failure of the emulsified asphalt to meet the material specification criteria at the time of application shall require the Contractor, at his own expense, to correct all unsatisfactory areas. No additional areas shall be sealed until correction has been made to the satisfaction or the Engineer.

2. Cover Aggregate – Pre-coated Chips

   a. Materials: Aggregate materials shall consist of an approximately cubic and uniformly-graded, hard, durable 100 percent crushed and washed limestone, sandstone, lightweight aggregate, basalt/porphyry, granitic material, steel slag, gravel, or chat. Chat is a by-product from the production of lead and zinc from the area located in southwestern Missouri, northeastern Oklahoma, and southeastern Kansas. Lightweight aggregate shall consist of expanded shale. The application rates reported in these specifications is for the Bethany Falls Limestone in the Kansas City area. The specific gravity of this material is approximately 2.58.

   b. Physical properties required of the aggregate materials:

Los Angeles Abrasion (ASTM C131)	35% loss (maximum)
Soundness using Mag. Sulfate (ASTM C 88, 5 cycles)	18% loss (maximum)
Soundness using Sodium Sulfate (ASTM C 88, 5 cycles)	12% loss (maximum)
Total Shale, clay, coal, and lignite content (ASTM C 142)	0.5% by weight (max)
Absorption	4.0% (max)

   c. Gradation: Gradation of cover aggregates shall conform to the following percentages:

Sieve Size	Percent Passing
3/4” (19mm)	100
1/2” (12.5mm)	90-95
3/8” (9.5mm)	30-50
No. 4 (4.75mm)	0-5
No. 8 (2.36mm)	0

d. Pre-coating of Chips: Aggregate chips shall be uniformly heated in a dryer until surface dry. All material shall be free of moisture, dust, and lumps and shall be approved by the Engineer prior to use. The aggregate chips shall then be pre-coated with 0.9%+ 0.025% a liquid asphalt cement having a viscosity of 2000 poise, +20%. The asphaltic material and hot aggregate shall be measured separately and accurately immediately before introduction into the mixer. Mixing shall be accomplished at a temperature between 275 º F and 325 º F, sufficient to produce a thoroughly and uniformly coated aggregate. The pre-coated chips shall be stockpiled at least 3 days prior to use.

3. Weighing: Weighing of cover aggregate shall be accomplished by the Contractor on scales that he furnishes for the purpose of weighing the cover aggregate as required in Section 2205.7 entitled "Scales and Weighing of Vehicles." All loads of cover aggregate will be weighed and evidenced by approved delivery tickets showing the net weight in pounds for each load. Two copies of each ticket shall accompany the load to the work site. Upon the load being incorporated in the work, the Engineer will sign both copies and one of these copies will be returned to the Contractor.

C. Spot Patching: Areas where base failure of the roadway has occurred, or where the surface is broken out shall be repaired prior to the sealing operation. The failed sections will be marked by the Engineer, and shall be removed by sawing a neat rectangular hole into the pavement. The failed material shall be removed without damage to the adjacent pavement. Where base failures have occurred, the pavement shall be removed to the subgrade which shall be corrected to the satisfaction of the Engineer prior to patching. Unstable material shall be overexcavated and replaced with base materials meeting the requirements of Section 2203. All surfaces shall be properly primed and tacked in accordance with Section 2204.

The prepared hole shall be patched with hot-mix asphaltic patching material by placing in layers not to exceed 2 inches; each layer being thoroughly compacted before the next layer is placed. After the patching material is placed and raked to a uniform surface, it shall be thoroughly compacted by rolling with a roller meeting the requirements of Section 2205.8. The edges shall be well bonded with the old surface. The completed patch shall be in the same plane as the existing pavement.

The asphaltic concrete used for patching at the different locations shall be as directed by the Engineer and shall conform to one of the mixes as set out in Section 2205.4.

D. Sealing

1. Cleaning: After all holes and cracks have been repaired to the satisfaction of the Engineer, and immediately before sealing the Contractor shall thoroughly clean the area to be sealed with a mechanical pickup type sweeper to insure proper adhesion of the new seal coat to the existing pavement. The street shall be dry before applying the seal coat.

2. Sealing: After the street has been prepared as set forth above the Contractor shall apply the emulsified asphalt by means of an approved distributor meeting the requirements of Section 2204.4. Provisions shall be made by the Contractor to properly protect the curbs and gutters from the asphaltic spray. Emulsified asphalt shall be applied at a rate between 0.28 and 0.35 gallons per square yard. The specific rate for each job will be determined by the Engineer in the field.

   Immediately after the application of the asphalt, the Contractor shall, by means of a self-propelled mechanical spreader, apply a uniform layer of cover aggregate. This material shall be spread at the rate specified by the Engineer. This rate shall be between 18 and 25 pounds per square yard of pre-coated limestone chips. The application rate shall be set to prevent bleeding of the asphaltic material

through the cover aggregate. If material is spread on any area in excess of the amount specified by the Engineer, the surplus shall be immediately removed and placed elsewhere as directed. No payment will be made to the Contractor for the picking up and redistribution of such excess. Hand spreading will be permitted only in those areas not accessible to the mechanical spreader.

Immediately after spreading the cover aggregate, the entire surface shall be rolled with multiple-wheel, pneumatic-type rollers meeting the requirements of Section 2205.8. Rolling shall be continued until a thoroughly compacted surface with a uniform aggregate coverage has been obtained, a minimum of 6 passes. The Engineer may require additional rollers if one roller cannot keep up with the operations. The first pass of the rollers over the cover aggregate shall not exceed 3 miles per hour. The rollers shall not exceed 5 miles per hour during any rolling operation.

Forty-eight hours after spreading the cover aggregate, the entire surface shall be swept with a mechanical pickup type sweeper to remove any loose or excess cover aggregate.

During the sealing operation as described above, the Contractor shall cooperate with the Engineer in arranging a program and schedule of work so traffic may be handled or routed around or through the section being sealed. Whenever possible, the street will be closed; but when this is not possible, the sealing will be done in strips while traffic is diverted to the balance of the street. No traffic will be permitted on the sealed portion of the roadway until rolling is completed. All traffic control signage shall conform to the MUTCD handbook for traffic control in work zones.

When bleeding occurs or more material is required, additional cover aggregate shall be spread as directed. As soon as the cover material has adhered to the surface, and the emulsion is thoroughly cured all excess cover aggregate shall be removed with a mechanical pickup type sweeper. This curing period is generally 48 hours, but may be adjusted by the Engineer.

2206.5 Unimproved Street Chip Seal

A. Description: This work shall consist of the application of a thin, uniform layer of liquified asphalt to the surface of the existing roadway which may either consist of an existing surface of asphaltic concrete pavement or a gravel-surfaced road. Cover aggregate shall then be distributed uniformly upon the liquified asphalt and seated in place with the use of a rubber-tired roller leaving a durable wearing surface.

B. Requirements for Liquified Asphalt Materials

Asphaltic materials used for the sealing of unimproved streets shall be liquified either by the introduction of a diluent (cutback) or by emulsification. The particular grade of cutback material for use on a particular roadway shall be determined by the Engineer. Cutback asphaltic materials shall comply with the requirements of either ASTM D 2027 or ASTM D 2028. The particular grade of emulsified asphalt material for use on a particular roadway shall be determined by the Engineer. Anionic emulsified asphaltic materials shall comply with the requirements for either a rapid or medium-setting emulsion as described in ASTM D 977 while cationic emulsified asphaltic materials shall comply with the requirements for either a medium or rapid-setting emulsion as described in ASTM D 2397.

C. Requirements for Cover Aggregate Materials

1. Aggregate materials shall consist of an approximately cubical and uniformly-sized, hard, durable 100 percent crushed and washed limestone, sandstone, lightweight aggregate, basalt/porphyry, granitic material, steel slag, gravel, or chat. Chat is a by-product from the production of lead and zinc from the area located in southwestern Missouri, northeastern Oklahoma, and southeastern Kansas. Lightweight

aggregate shall consist of expanded shale. Due to the variation in specific gravities between these materials, the application rate will need to be adjusted to reflect the change in specific gravity. The application rates reported in these specifications is for the Bethany Falls Limestone in the Kansas City area. The specific gravity of this material is approximately 2.58.

2. Physical properties required of the aggregate materials:

Los Angeles Abrasion (ASTM C 131)	35% loss (maximum)
Soundness using Mag. Sulfate (ASTM C88, 5 cycles)	18% loss (maximum)
Soundness using Sodium Sulfate (ASTM C 88, 5 cycles)	12% loss (maximum)
Total Shale, clay, coal, and lignite content (ASTM C 142)	0.5% by weight (max)
Absorption	4.0% (max)

Aggregate chips applied to cutback asphalt shall be shown to have a moisture content less than 1 percent immediately prior to application. Aggregate chips applied to emulsified asphalt shall be shown to have a moisture content of 3 percent or less immediately prior to application.

Gradation for aggregate chips used for Single sealing:

Square Sieve Size	Percent Passing
1/2" (12.5mm)	100
3/8" (9.5mm)	80-100
No. 4 (4.75 mm)	0-26
No. 10 (2.00mm)	0-2

Gradation for aggregate chips used for the first application of a Double sealing:

Square Sieve Size	Percent Passing
3/4" (19mm)	100
1/2" (12.5mm)	90 to 100
3/8" (9.5mm)	40 to 70
No. 4 (4.75mm)	0 to 15
No. 10 (2.0mm)	0-2

Gradation for aggregate chips used for the second application of a Double sealing shall conform to the gradation for a Single sealing above.

The Contractor shall furnish scales for weighing cover aggregate as required in Section 2201.7 entitled "Scales and Weighing of Vehicles". All loads of cover aggregate will be weighed as required, and evidenced by approved delivery tickets showing the net weight in pounds for each load. Two copies of each ticket shall accompany the load to the work site. In order for the load to be received and incorporated into the work, both copies will be signed by the Engineer (or inspector) and one of these copies returned to the Contractor.

D. Sealing

Sealing shall be accomplished in the same manner as described in Section 2206.3.D except as modified herein. Where a seal coat is applied to a gravel-surface roadway the surface shall be prepared in accordance with Section 2204.4. The surface shall then be primed in accordance with Section 2204.4 prior to the application of the seal coat.

The application rate of cutback asphalt shall be in the range 0.25 to 0.45 gallons per square yard as directed by the Engineer or demonstrated to result in a satisfactory seal in a test strip provided by the Contractor. Anti-Strip agent may be added to Cutback Asphalt at a rate not to exceed 1 percent of the residual asphalt volume as directed by the Engineer in order to improve adhesion of the asphalt to the moist aggregates. The cutback agent shall be thoroughly mixed and blended with the cutback asphalt. The application rate of emulsified asphalt shall be in the range of 0.28 to 0.40 gallons per square yard as approved or directed by the Engineer. The distributor used shall meet the requirements of Section 2204.4.

Limestone materials shall be spread at the rate specified by the Engineer with the range of 16 to 24 pounds per square yard.

Where double sealing is indicated on the Plans or required by the Engineer, the area shall be treated with two seal coats. The application rate of the asphaltic material for the first application shall be approximately one-half of that used for a single seal with the remainder applied during the second seal application. The application rate of the first application of cover aggregate shall be within the range specified for a single seal. The application rate of the second application shall be approximately one-half the application rate of the first layer.

2206.6 Improved Street Slurry Seal

A. Description: This work shall consist of the application of Slurry Seal Material to an existing surface. The Slurry Seal shall consist of a mixture of emulsified asphalt, mineral aggregate and potable water, properly proportioned, mixed and spread on the surface in accordance with this specification and as directed by the Engineer.

B. Material

1. Emulsified Asphalt: The emulsified asphalt shall conform to Grade SS-1h of ASTM D 977, for emulsified asphalt, or Grade CSS-1h of ASTM D 2397, for cationic emulsified asphalt. Quick-set emulsified asphalts QS-1h and CQS-1h may also be used. They shall conform to ASTM D 977 and ASTM D 2397 respectively, except that the test requirements for cement mixing and storage stability shall not apply. Refer to the International Slurry Surfacing Association (ISSA) Bulletin No. 139. The emulsified asphalt shall have not less than 60% residue after distillation when tested using ASTM D 244 and shall have a penetration of between 40 and 90 when tested using ASTM D 2397 at 77° F. Each load of emulsified asphalt delivered shall have a certificate of analysis/compliance matching the material used in the mix design.

2. Aggregate for Slurry Seal: The mineral aggregate used for this work shall be natural or manufactured crushed granite, slag, or chat which is a byproduct of the milling of lead and zinc ores and shall conform to one of the following grading requirements when tested in accordance with ASTM C 136 and ASTM C 117. All aggregate shall conform to the quality requirements of ASTM D 1073.

GRADING REQUIREMENTS FOR AGGREGATE			
Sieve Size	Amount Passing Sieves, Weight %		
	Type I	Type II	Tolerance
3/8 inch (9.5 mm)	100	100	
No. 4 (4.75 mm)	100	90 – 100	+/- 5%
No. 8 (2.36 mm)	90 – 100	65 – 90	+/- 5%
No. 16 (1.18 mm)	65 – 90	45 – 70	+/- 5%
No. 30 (600 um)	40 – 65	30 – 50	+/- 5%
No. 50 (300 um)	25 – 42	18 – 30	+/- 4%
No. 100 (150 um)	15 – 30	10 – 21	+/- 3%
No. 200 (75 um)	10 - 20	5 – 15	+/- 2%

The percent passing the No. 200 (75 um) sieve shall be determined by ASTM C 117.

3. Mineral Filler: Mineral Fillers are of two types, chemically active and chemically inactive. Both shall conform to ASTM D 242. Chemically active mineral fillers such as Portland cement, hydrated lime, and ammonium sulfate are used to improve workability, regulate the setting time, and, in some cases, to alter the aggregate gradation. Chemically inactive mineral fillers such as limestone dust, fly ash, and rock dust are used mainly to alter aggregate gradation.

4. Water: All water used shall be potable and shall be free of harmful salts or contaminates.

5. Mix Design: The Engineer shall approve all slurry seal materials and methods prior to mixing and application. The Contractor shall submit a completed and tested slurry seal mix design for the Engineer's approval. The approved test method for emulsified asphalt slurry seal shall be found in ASTM D 3910. The mix design shall be made with the same materials the Contractor will be using on the project. The percentage of each material must be shown on the mix design. Proportions of the mixture shall be as follows unless variations are approved by the Engineer:

	TYPE I	TYPE II
Aggregate for Slurry Seal	8.0 to 12.0 lbs per sq yd 3.63 to 5.44 kg/m^2 (dry basis)	13.5 to 16.5 lbs per sq yd 7.32 to 8.95 kg/m^2 (dry basis)
Emulsified Asphalt (Residual Asphalt Content)	10.0 to 16.0% by weight of dry aggregate	7.5 to 13.5% by weight of dry aggregate
Mineral Filler	1.5 to 3.0% by weight of dry aggregate	1.5 to 3.0% by weight of dry aggregate
Water	Minimum amount necessary to obtain a fluid and homogenous mixture	Minimum amount necessary to obtain a fluid and homogenous mixture

Once the proper consistency is obtained, changes in proportioning of the various components of the mixture shall be held to a minimum.

6. Application Rates: The slurry seal mixture shall be of proper consistency at all times so as to provide the application rate required by the surface condition and shall be in accordance with the following:

Type I: 8.0 to 12.0 lbs per sq yd
Type II: 13.5 to 20 lbs per sq yd

Application rates are affected by the unit weight of the aggregate, the gradation of the aggregate and

the demand of the surface to which the slurry seal is being applied.

7. Equipment: The slurry mixing machine shall be a continuous flow mixing unit and shall be capable of delivering accurately a predetermined proportion of aggregate, water and asphalt emulsion to the mixing chamber and to discharge the thoroughly mixed product on a continuous basis. The equipment shall be capable of pre-wetting the aggregate immediately prior to mixing with the emulsion. The mixing unit of the mixing chamber shall be capable of thoroughly blending all of the components together without violent mixing. The mixing machine shall be equipped with an approved fines feeder that includes an accurate metering device or method to introduce a predetermined proportion of mineral filler into the mixer. The mineral filler shall be fed at the same time and location as the aggregate. The fines feeder shall be required whenever added mineral filler is a part of the aggregate blend. The mixing machine shall be equipped with a water pressure system and fog-type spray bar, adequate for complete fogging of the surface receiving slurry treatment. Attached to the mixer machine shall be a mechanical type squeegee distributor, equipped with flexible material in contact with the surface of the pavement to prevent loss of slurry from the distributor. It shall be maintained so as to prevent loss of slurry on varying grades and crown by adjustments to insure uniform spread. There shall be a steering device and a flexible strike-off. The spreader box shall have an adjustable width. The box shall be kept clean and build-up of asphalt and aggregate on the box or in the corners shall not be permitted. Use of burlap drags or other drags shall be approved by the Engineer. Hand squeegees, shovels, and other equipment shall be provided if necessary to supplement the slurry mixing machine. Power brooms, power blowers, air compressors, and hand brooms suitable for cleaning the surface and cracks of the existing surface shall be implemented to provide a clean surface.

8. Construction Requirements

   a. Surface Preparation: Immediately prior to applying the slurry, clean the surface of all loose material, mud spots, vegetation, and other objectionable material. Any standard cleaning method used to clean pavements will be acceptable except water flushing. A pickup sweeper must be used unless otherwise approved by the Engineer. Manholes, valve boxes, drop inlets, and other service entrances shall be protected from the slurry seal by a method approved by the Engineer.
   b. Application: The surface shall be pre-wetted by fogging ahead of the slurry box unless waived by the Engineer. Water used in pre-wetting the surface shall be applied at such a rate that the entire surface is damp with no apparent flowing water in front of the slurry box. The slurry mixture shall be of the desired consistency upon deposit on the surface and no additional elements shall be added. Total time of mixing shall not exceed four (4) minutes. A sufficient amount of slurry shall be carried in all parts of the spreader at all times so that a complete coverage is obtained. Overloading of the spreader shall be avoided. No lumping, balling, or unmixed aggregate shall be permitted. No segregation of the emulsion and aggregate fines from the coarse aggregate shall be permitted. If the coarse aggregate settles to the bottom of the mix, the slurry shall be removed from the pavement. No excessive breaking of emulsion shall be allowed in the spreader box. No streaks, such as those caused by oversized aggregate will be left in the finished pavement.
   c. Hand Work: Approved squeegees shall be used to spread slurry in areas not accessible to the slurry mixer. Care should be exercised in leaving no unsightly appearance from the hand work.
   d. Curing: Treated areas shall be allowed to cure for four hours, or until such time as the Engineer permits their opening to traffic.
   e. Weather Limitation: The slurry seal shall not be applied if either the pavement or air temperature is below 60° F and falling. The mixture shall not be applied if the relative

humidity exceeds 80%.

f. Traffic Control: Suitable methods shall be used to protect the slurry from all types of traffic until sufficiently cured to accept traffic. The length of time before traffic is permitted to use the surface depends on the type of emulsified asphalt, mixture characteristics, and weather conditions.

g. Lines: Care shall be taken to insure straight lines along curb and shoulders. No runoff on these areas will be permitted. Lines at intersections will be kept straight to provide good appearance.

h. Property Owners Notification: The Contractor shall supply and place door tags on the doors of all involved property owners. The door tag language shall be approved by the Engineer.

i. Provisions for Public Convenience During Sealing Operation: The Contractor shall provide and maintain sufficient signs, barricades, warning lights, flag persons and watch persons to protect the work and public in a manner satisfactory to the Engineer. Any areas damaged prior to acceptance by the Engineer shall be repaired at the Contractor's expense. "No Parking" signs will be furnished by the Contractor. These signs shall comply with the standards established by the MUTCD with regard to size, color, working height and placement. When "No Parking" signs are posted on the streets with parking meters, the Contractor shall cover the parking meter heads with cloth or paper bags. The Contractor shall take all necessary precautions to protect the public (pedestrian and vehicular) from flying debris. The Contractor shall use warning signs and devices to warn motorists and pedestrians of work ahead.

2206.7 Improved Street Micro-Surfacing

A. Description: This work shall consist of the application of a polymer modified asphalt emulsion, mineral aggregate, mineral filler, potable water, and other additives, properly proportioned, mixed and spread on a paved surface in accordance with this specification and as directed by the Engineer.

B. Materials

1. Emulsified Asphalt: The emulsified asphalt shall be a quick wet polymer modified asphalt emulsion conforming to the requirements specified in ASTM D 2397 or AASHTO M 208 for Grade CSS-1h. The cement mixing test shall be waived for this emulsion. The polymer material shall be milled or blended into the asphalt or emulsifier solution prior to the emulsification process. The emulsified asphalt shall have not less than 62% residue after distillation when tested using ASTM D 244. The temperature for this test shall be held below 280° F. Higher temperatures may cause the polymers to break down. In addition, the emulsified asphalt shall have a penetration of between 40 and 90 when tested using ASTM D 2397 at 77° F (25° C) and shall have a minimum softening point of 135° F when tested using ASTM D 36. Each load of emulsified asphalt delivered shall have a certificate of analysis/compliance matching the material used in the mix design.

2. Aggregate for Micro-Surfacing: The aggregate shall be a manufactured crushed stone such as granite, or chat which is a by-product of the milling of lead and zinc ores. The aggregate shall be totally crushed with 100% of the parent aggregate being larger than the largest stone in the gradation to be used. The mineral aggregate used shall conform to one of the following grading requirements when tested in accordance with ASTM C 136 and ASTM C 117. All aggregate shall conform to the quality requirements of ASTM D 1073.

GRADING REQUIREMENT FOR AGGREGATE			
Sieve Size	Amount Passing Sieves, Weight %		
	Type I	Type II	Tolerance
3/8 inch (9.5 mm)	100	100	
No. 4 (4.75 mm)	90 – 100	70 – 90	+/- 5%
No. 8 (2.36 mm)	65 – 90	45 – 70	+/- 5%
No. 16 (1.18 mm)	45 – 70	28 – 50	+/- 5%
No. 30 (600 um)	30 – 50	19 – 34	+/- 5%
No. 50 (300 um)	18 – 30	12 – 25	+/- 4%
No. 100 (150 um)	10 – 21	7 – 18	+/- 3%
No. 200 (75 um)	5 - 15	5 – 15	+/- 2%

The combined aggregate prior to the addition of any chemically active mineral filler shall have a sand equivalent of not less than 65 when tested by ASTM D 2419. The aggregate shall have a weighed average loss not greater than 25% using magnesium sulfate when tested by ASTM C 88. Testing of abrasion resistance shall not exceed 30% when tested by ASTM C 131.

3. Mineral Filler: Mineral filler shall be any recognized brand of non-air entrained Portland cement or hydrated lime. The mineral filler shall be free of lumps and accepted upon visual inspections. The type and amount of mineral filler needed shall be determined by a laboratory mix design and will be considered as part of the aggregate gradation.

4. Water: All water used shall be potable and shall be free of harmful salts or contaminates.

5. Additives: Additives may be added to the emulsion mix or any of the component materials to provide the control of the quick-traffic properties. They must be included as part of the mix design and be compatible with the other components of the mix.

6. Mix Design: The Engineer shall approve all micro-surfacing materials and methods prior to mixing and application. The Contractor shall submit a completed and tested micro-surfacing mix design for the Engineer's approval. The approved test method for micro-surfacing shall be found in ASTM D 6372. The mix design shall be made with the same materials the Contractor will be using on the project. The percentage of each material must be shown on the mix design. Proportions of the mixture shall be as follows unless variations are approved by the Engineer.

	TYPE I	TYPE II
Aggregate for Micro-surfacing	10.0 to 20.0 lbs per sq yd 4.53 to 9.07 kg/m^2 (dry basis)	13.5 to 16.5 lbs per sq yd 7.32 to 8.95 kg/m^2 (dry basis)
Emulsified Asphalt (Residual Asphalt Content)	7.5 to 13.5% by weight of dry aggregate	7.5 to 13.5% by weight of dry aggregate
Polymer Based Modifier	Minimum of 3% solids based on asphalt weight content	Minimum of 3% solids based on asphalt weight content
Additive	As needed	As needed
Mineral Filler	0.0 to 3.0% by weight of dry aggregate	0.0 to 3.0% by weight of dry aggregate
Water	Minimum amount necessary to obtain a fluid and homogenous mixture	Minimum amount necessary to obtain a fluid and homogenous mixture

Once the proper consistency is obtained, changes in proportioning of the various components of the mixture shall be held to a minimum.

7. Application Rates: The Micro-Surfacing mixture shall be of proper consistency at all times so as to provide the application rate required by the surface condition and shall be in accordance with the following:

   Type II: 10.0 to 20.0 lbs per sq yd
   Type III: 15.0 to 30.0 lbs per sq yd

   Application rates are affected by the unit weight of the aggregate, the gradation of the aggregate, and the demand of the surface to which the micro-surfacing is being applied.

8. Equipment

   a. Micro-Surfacing Mixing Equipment: The micro-surfacing mixing machine shall be specifically designed and manufactured to lay micro-surfacing. The machine shall be self-propelled, continuous flow mixing unit able to accurately deliver and proportion the aggregate, emulsified asphalt, mineral filler, control setting additive, and water to a revolving multi-blade double-shafted mixer and discharge the mixed product on a continuous flow basis. The machine shall have sufficient storage capacity for aggregate, emulsified asphalt, mineral filler, control additive, and water to maintain an adequate supply to the proportioning controls. On major highway work, the machine may be required to be a self-loading machine capable of loading materials while continuing to lay micro-surfacing. The self-loading machine shall be equipped to allow the operator to have full control of the forward and reverse speed during application of the micro-surfacing material and be equipped with opposite side drivers stationed to assist in alignment. The self-loading device, opposite side drivers stations, and forward and reverse speed controls shall be original equipment manufacturer designed.
   b. Proportioning Devices: Individual volume or weight controls for proportioning each material, and used in material calibration, shall be provided and properly marked.
   c. Calibration: Each mixing unit to be used in the performance of the work shall be calibrated prior to construction. Calibration documentation shall include an individual calibration of each material at various settings, which can be related to the machine metering devices. No machine will be allowed to work on the project until a calibration has been completed. Final calibration sheets shall be provided to the Engineer for acceptance.
   d. Micro-Surfacing Spreading Equipment: The machine shall include a surfacing box with twin-

shafted paddles or spiral augers fixed in a spreader box. A flexible front seal shall be provided to insure no loss of mixture at the road surface contact point. The rear flexible seal shall act as a final strike-off and shall be adjustable in width. The spreader box and rear strike-off shall be so designed and operated that a uniform consistency is achieved to produce a free flow of material to the rear strike-off box. The box shall have suitable means provided to side-shift the box to compensate for variations of pavement geometry. A secondary strike-off shall be provided to improve the surface texture. It shall have the same leveling adjustments as the spreader box.

e. Auxiliary Equipment: Hand squeegees, shovels, traffic control equipment, and other support and safety equipment shall be provided as necessary to perform the work.

f. Cleaning Equipment: Power brooms, pickup sweepers, power blowers, air compressors, and hand brooms suitable for cleaning shall be utilized to provide a clean surface.

9. Construction Requirements

a. Surface Preparation: Immediately prior to applying the micro-surfacing, the surface shall be cleaned of all loose material, silt spots, vegetation, and objectionable material as determined by the Engineer. Any standard cleaning method used to clean pavements will be acceptable except water flushing. Manholes, valve boxes, drop inlets, and other service entrances shall be protected from the micro-surfacing by a method approved by the Engineer.

b. Application: If the pavement area to be covered is extremely oxidized and raveled or is concrete or brick, a tack coat may be required at the discretion of the Engineer. The tack coat shall conform to Section 2204 and shall be a SS or CSS grade. The tack coat shall be allowed to break sufficiently before the application of micro-surfacing. The surface shall be pre-wetted by fogging ahead of the spreader box unless waived by the Engineer. Water used in pre-wetting the surface shall be applied at such a rate that the entire surface is damp with no apparent flowing water in front of the spreader box. The micro-surfacing mixture shall be of the desired consistency upon deposit on the surface and no additional elements shall be added. A sufficient amount of material shall be carried in all parts of the spreader box at all times so that a complete coverage is obtained. Overloading of the spreader box shall be avoided. No lumping, balling, or unmixed aggregate shall be permitted. No streaks, such as those caused by oversized aggregate shall be left in the finished surface.

c. Hand Work: Areas which cannot be reached with the mixing machine shall be surfaced using approved hand squeegees to provide a complete and uniform coverage. If necessary, the area to be hand-worked shall be lightly dampened prior to mix placement. The same type of finish as applied by the spreader box shall be required.

d. Curing: Micro-surfacing shall be allowed to cure for one hour, or until the Engineer permits opening the street to traffic.

e. Weather Limitation: Micro-surfacing shall not be applied if either the pavement or air temperature is below 60° F and falling. The mixture shall not be applied if the relative humidity exceeds 80%.

f. Traffic Control: Suitable methods shall be used to protect the micro-surfacing from all types of traffic until sufficiently cured to accept traffic. The length of time before traffic is permitted to use the surface shall be determined by the Engineer.

g. Lines: Care shall be taken to insure straight lines along curb and shoulders. No runoff on these areas will be permitted. Lines at intersections will be kept straight to provide good appearance.

h. Property Owners Notification: The Contractor shall supply and place door tags on the doors of all involved property owners. The door tag language shall be approved by the Engineer.

i. Provisions for Public Convenience During Surfacing Operation: The Contractor shall provide and maintain sufficient signs, barricades, warning lights, flag persons and watch persons to

protect the work and public in a manner satisfactory to the Engineer. Any areas damaged prior to acceptance by the Engineer shall be repaired at the Contractor's expense. "No Parking" signs will be furnished by the Contractor. These signs shall comply with the standards established by the MUTCD with regard to size, color, working height and placement. When "No Parking" signs are posted on the streets with parking meters, the Contractor shall cover the parking meter heads with cloth or paper bags. The Contractor shall take all necessary precautions to protect the public (pedestrian and vehicular) from flying debris. The Contractor shall use warning signs and devices to warn motorists and pedestrians of work ahead.

2206.8 Method of Measurement

A. Asphaltic Crack Seal will be measured per pound.

B. Chip seal will be measured by one of the following:

1. Per square yard or tenth part thereof.

2. Actual quantities used:

   a. Asphaltic concrete patch, per ton or tenth part thereof.
   b. Bitumen (asphaltic cement or liquid asphalt) per gallon.
   c. Coated cover aggregate, per ton or tenth part thereof.

C. Slurry seal will be measured per square yard or tenth part thereof.

D. Micro-surfacing will be measured per square yard or tenth part thereof.

2206.9 Basis of Payment

A. Asphaltic Crack Seal will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

B. Chip Seal will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

C. Slurry Seal will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

D. Micro-surfacing will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

SECTION 2207 COLD MILLING

2207.1 Scope

This section governs the furnishing of all labor, materials and equipment for the performance of cold milling pavement surfaces as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions. This work will consist of the removal of the existing surface, loading, hauling, and stockpiling, if required, of the milled material and the cleaning of the milled surface.

2207.2 Equipment

Milling the surface of pavements shall be completed by the use of a milling machine conforming to the following:

A. Machine: The cold milling machine shall be self-propelled and able to automatically control grade and slope of the milled surface. Operate the automatic grade and slope control from a travelling stringline a minimum of 30 feet long, attached the milling machine and operating parallel to the direction of travel. Other methods of positive grade control may be used if approved by the Engineer. The machine shall have the means of milling without damaging the remaining pavement (torn, gouged, shoved, broken, etc.). The machine shall be capable of blading the cuttings into a single windrow or depositing them directly into a truck.

B. Air Pollution: The machine shall be equipped with a dust suppression system including water storage tanks and high pressure spray bars.

C. Operating Width: It is desirable that the cutting width be greater than 6 feet. In the event the cutting width is less than 6 feet, a system of electronic grade control for consecutive passes will be required.

D. Cutting Drum: The cutting drum shall be totally enclosed to prevent discharge of any loosened material on adjacent work areas.

2207.3 Construction

A. Methods of Operations for Milling

1. Utilities: Street surfaces adjacent to manholes, water valves and other utility extensions shall be completely removed to the full depth of cut specified for the street unless otherwise specified by the Engineer.

2. Material Disposal: All material from the milling operation shall be removed immediately from the surface of the pavement and properly disposed of by the Contractor at an approved disposal area.

3. Surface Conditions: The drum lacing patterns shall produce a smooth surface finish after milling, with groove depths not to exceed 1/4 inch and groove spacing not to exceed 1 inch unless otherwise approved by the Engineer.

B. Types of Cuts to be made by Milling

1. Leveling: Sufficient passes shall be made such that all irregularities or high spots are eliminated, and that 100% of the surface is milled.

2. Average Depth: Sufficient passes, or cuts, shall be made in order to remove a specified depth over the entire street section. These depths will be designated in the Plans or Special Provisions.

3. Curb Cut: Sufficient passes or cuts shall be made to remove the specified depth at the curb for a specified width. These dimensions will be designated in the Plans or Special Provisions.

4. Bridge Deck Milling: Sufficient passes, or cuts, shall be made in order to remove the material as specified on the Plans or in the Special Provisions.

C. Cleanup: All loose asphalt and debris shall be removed from the street surface and curb and gutter. Any material and debris that adheres to the curb and gutter shall be removed.

D. Opening to Traffic: If the milled area will be opened to traffic prior to surfacing, provide a smooth riding surface by either milling or placing a wedge of hot mix asphalt or other approved material of a thickness and design that will remain in place under traffic. The transition between the milled area and transverse joints shall be a minimum of 1 vertical to 24 horizontal. The transition between the milled surface and manholes, utility fixtures or other appurtenances shall be a minimum of 1 vertical to 12 horizontal. Transitions shall be removed prior to surfacing.

2207.4 Method of Measurement

Cold milling will be measured per square yard or tenth part thereof for the specified depth.

2207.5 Basis of Payment

Cold milling will be paid for by one of the following:

A. Contract unit bid price.

B. Contract lump sum bid price.

SECTION 2208 PORTLAND CEMENT CONCRETE PAVEMENT

2208.1 Scope

This section governs the furnishing of all labor, materials and equipment for the placement of Portland Cement Concrete Pavement as shown on the Plans and in accordance with the Standard Drawings, the specifications, and the Special Provisions.

2208.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

ASTM
A 615 Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
A 775 Standard Specification for Epoxy-Coated Steel Reinforcing Bars

A 1064 Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
C 31 Standard Practice for Making and Curing Concrete Test Specimens in the Field
C 39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
C 143 Standard Test Method for Slump of Hydraulic-Cement Concrete
C 172 Standard Practice for Sampling Freshly Mixed Concrete
C 231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
C 309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
C 1064 Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete

D 1751 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
D 1752 Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
D 2628 Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
D 2835 Standard Specification for Lubricant for Installation of Preformed Compression Seals in Concrete Pavements
D 6690 Standard Specification for Joint and Crack Sealants, Hot-Applied, for Concrete and Asphalt Pavements
D 7174 Standard Specification for Preformed Closed-Cell Polyolefin Expansion Joint Fillers for Concrete Paving and Structural Construction
E 965 Test Method for Measuring Surface Macrotexture Depth Using a Sand Volumetric Technique

AASHTO
M 148 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
M 213 Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
M 324 Joint Sealants, Hot-Poured, for Concrete and Asphalt Pavements

MCIB Mid-West Concrete Industry Board Concrete Specifications - Concrete Pavement
The current editions of the "Bulletins" and Approved Sections of the "Standard Concrete Specifications" issued by the Mid-West Concrete Industry Board, Inc. (MCIB) are made a part hereof by reference. However, when the provisions of this Specification differ from the provisions of such "Bulletins" and "Sections" the provisions of this Specification shall govern.

KCMMB Kansas City Metro Materials Board Specifications

Kansas Department of Transportation
Standard Specifications for State Road and Bridge Construction, 2015 Edition

Missouri Highways and Transportation Commission
Missouri Standard Specifications for Highway Construction, 2011 Edition

National Concrete Pavement Technology Center Guide Specifications for Concrete Overlays, September 2015, including latest revisions

2208.3 Materials

A. Concrete: Concrete shall conform to referenced specifications as called out in the Contract Documents. If no direct reference to concrete specifications is included in the Contract Documents, concrete shall meet KCMMB

specifications.

1. If KCMMB concrete is specified, an approved KCMMB concrete mix shall be required.

2. If MCIB concrete is specified, concrete shall comply with MCIB Section entitled “Concrete Pavement”.

3. If KDOT specifications are referenced for concrete, provide material in compliance with the latest version of KDOT specifications. Approval of component materials will be based on submittal of certifications from supplier. Aggregates shall meet the quality requirements specified by KDOT. Engineer reserves the right to perform testing of components to verify compliance.

4. If MoDOT specifications are referenced, provide material in compliance with the latest version of MoDOT specifications. Approval of component materials will be based on submittal of certifications from supplier. Aggregates shall meet the quality requirements specified by MoDOT. Engineer reserves the right to perform testing of components to verify compliance.

5. Proposed concrete mix designs for use on the project shall be submitted to Engineer for approval at least two (2) weeks in advance of anticipated use. Mix design shall be approved prior to use of that mix.

6. Field testing of concrete shall be performed by the Engineer at the frequency required by the referenced specification. Unless otherwise specified, the following tests shall be performed once for every 50 cuyd of concrete placed:

    a. Sampling of fresh concrete per ASTM C 172
    b. Slump per ASTM C 143
    c. Air Content per ASTM C 231
    d. Temperature per ASTM C 1064
    e. Cylinders cast per ASTM C 31 and tested per ASTM C 39. Four cylinders shall be cast with one tested at 7 days, 2 tested at 28 days and one held in reserve.

7. For concrete overlays, material and construction specifications shall be governed by the National Concrete Pavement Technology Center Guide Specifications for Concrete Overlays, September 2015, including latest revisions.

B. Reinforcement

1. Bars: Non-epoxy coated bars shall conform to ASTM A 615. Epoxy coated bars shall conform to ASTM A 775.

2. Welded Steel Wire: Welded steel wire fabric shall conform to ASTM A 1064.

3. Supporting Elements: Representative samples of supporting elements shall be submitted and approved by the Engineer prior to their use in the project.

4. Fibers: When specified in the Contract Documents, fibers shall be incorporated into the concrete at the rate recommended by the manufacturer but no less than a minimum of 3 pounds per cubic yard of concrete for macro fibers and 1 pound per cubic yard of concrete for micro fibers. Fibers shall meet the requirements of KDOT Standard Specifications for State Road and Bridge Construction, 2015 Edition, Section 1722.2. Micro fibers are used to control plastic shrinkage cracks in concrete while macro fibers control cracking in hardened concrete and are often used as a substitute for traditional crack

control steel reinforcing bars or mesh. In addition, macro fibers add toughness, and impact and fatigue resistance to hardened concrete.

C. Isolation Joint Fillers: Isolation joint fillers shall conform to ASTM D 1751, D 1752, or ASTM D 7174.

D. Joint Sealing Compounds: Joint sealing compounds shall conform to the standards for the type of sealant specified as listed in the following table:

Joint Seals and Sealants	AASHTO	ASTM
Hot-poured, Polymeric Asphalt Based	M 324	D 6690
Preformed Polychloroprene Elastomeric		D 2628
Lubricant for Installation of Preformed Seal	-----	D 2835
Preformed Expansion Joint Filler	M 213	D 1751, D 1752 or D 7174

E. Curing Membrane: All material to be used or employed in curing Portland Cement Concrete must be approved by the Engineer prior to its use. It shall be of the liquid membrane type and shall conform to ASTM C 309, Type II, Class B or AASHTO M 148, Type 2, white pigmented.

2208.4 Construction

Portland Cement Concrete Pavement shall be constructed to the configuration, and to the lines and grades shown on the Plans.

A. Grading, Subgrade Preparation and Base Course: All excavation, embankment, subgrade stabilization or aggregate base course required shall be as defined in Sections 2100 “Grading and Site Preparation”, 2201 "Subgrade Preparation", 2202 “Subgrade Stabilization”, and 2203 “Aggregate Base Course”. If areas of the subgrade are below the lines, grades and cross-sections shown on the Plans, they shall be brought to the proper line, grade and cross-section by one of the following:

1. Additional fill material placed in accordance with applicable sections.

2. Areas may be filled with additional thickness of Portland Cement Concrete Pavement.

B. Surface Preparation for Concrete Overlay: Prepare surface for concrete overlay as specified in the National Concrete Pavement Technology Center Guide Specifications for Concrete Overlays, September 2015.

C. Forms: All forms shall be in good condition, clean, and free from imperfections. Each form shall not vary more than 1/4 inch in horizontal and vertical alignment for each 10 feet of length.

1. Material & Size: Forms shall be made of metal and shall have a height equal to or greater than the prescribed edge thickness of the pavement slab. Wood forms may be substituted when approved by Engineer and if they are free from warp with sufficient strength for the intended application.

2. Strength: Forms shall be of such cross-section and strength, and so secured as to resist the pressure of the concrete when struck off, vibrated, and finished, and the impact and vibration of any equipment which they may support.

3. Installation: Forms shall be set true to line and grade, supported through their length and, joined neatly in such a manner that the joints are free from movement in any direction.

4. Preparation: Forms shall be cleaned and lubricated prior to each use and shall be so designed to permit their removal without damage to the new concrete.

D. Joints: Generally joints shall be formed at right angles to the true alignment of the pavement and to the depths and configuration specified by the appropriate standard or as modified by the Plans and specifications. For additional guidance on jointing, see American Concrete Paving Association jointing guides. All joints shall be sealed with sealant meeting the requirements of Section 2208.3.D. Unless specified otherwise on the Plans, specifications, Standard Drawings or Special Provisions, use hot-poured joint sealant.

1. Isolation Joints: Isolation joints shall be placed at all locations where shown on the Plans and Standard Drawings or as directed by the Engineer.

    a. Isolation joints shall extend the entire width of the pavement and from the subgrade to the surface of the pavement. The material will have a suitable tear strip or removable cap provided to allow for the application of the joint sealer to the required depth.
    b. Under no circumstances shall any concrete be left across the isolation joint at any point.
    c. Material: Isolation joints shall be formed by a one-piece, one inch thick preformed joint filler cut to the configuration of the correct pavement section.
    d. Stability: Isolation joints shall be secured in such a manner that they will not be disturbed during the placement, consolidation and finishing of the concrete.
    e. Dowels: If isolation joints are to be equipped with dowels they shall be of the size and type specified, and shall be firmly supported in place, by means of a dowel basket or other support method approved by the Engineer, which shall remain in place. Each dowel shall be lightly painted or greased with a product approved by the Engineer.

2. Contraction Joints: Contraction joints shall be placed where indicated and to the depth indicated by the Plans, specifications and Standard Drawings.

    a. Method: Contraction joints shall be sawed.
    b. When sawing joints, the Contractor shall begin as soon as the concrete hardens sufficiently to prevent excessive raveling along the saw cut and shall finish before conditions induce uncontrolled cracks, regardless of the time or weather. All sawed joints shall begin with a relief cut that shall be approximately 1/8 inch wide, and a minimum of 1/3 the thickness of the slab unless shown otherwise on the Plans. If the Plans indicate a joint width greater than 1/8" but with no backer rod, the Contractor may saw the initial relief cut to the full width. If a reservoir cut is specified that uses a backer rod, a second stage saw cut which widens the joints to allow the insertion of joint sealing material shall be performed. The second stage saw cut shall not be performed until the concrete is at least 48 hours old and shall be delayed longer when the sawing causes raveling of the concrete. If second stage sawing is performed prior to the completion of the curing period, the Contractor shall maintain the cure by use of materials approved by the Engineer.
    c. The Contractor shall be responsible for using suitable methods to cut joints straight and in the correct location. The Contractor shall protect joints from damage until completion of the project and shall repair damaged joints to the satisfaction of the Engineer.
    d. Where not indicated on the Plans or Standard Drawings, joint spacing for concrete overlays shall not exceed 12 times the thickness of the overlay, and shall be constructed such that the larger dimension of any panel does not exceed 125% of the smaller dimension. Joints of adjacent panels shall be aligned. Joints shall intersect pavement free edges at 90 degrees, and shall extend a minimum of 1 foot from the pavement edge. Saw joints shall be one-third the thickness of the slab, or two inches, whichever is greater.

e. For bonded concrete overlays, joints shall be located above existing joints, shall be sawed full depth plus one-half inch for overlays up to 4 inches in two stages. The first stage provides a relief cut approximately 1/8 inch wide.

f. Dowels: If contraction joints are to be equipped with dowels they shall be of the size and type specified and shall be firmly supported in place and accurately aligned parallel to the pavement line and grade with an allowable tolerance of 1/8 inch.

3. Longitudinal and Construction Joints: Longitudinal joints and construction joints shall be placed as shown on the Plans or where the Contractor's construction procedure may require them to be placed with approval of the Engineer. Longitudinal construction joints (joints between construction lanes) shall be keyed or tied joints of the dimensions shown on the Plans or Standard Drawings. Transverse construction joints of the type shown on the Plans or Standard Drawings shall be placed wherever concrete placement is suspended for more than 30 minutes. Unless shown otherwise on the Plans, do not place a construction joint within 5 feet of another transverse expansion, contraction or construction joint.

4. Center Joints: Longitudinal center joints shall be constructed using the methods specified in Section 2208.4.D.2 "Contraction Joints".

5. Tie Bars: Tie bars shall be deformed steel of the dimensions specified by the Plans or Standard Drawings. Tie bars shall be installed at the specified spacing and firmly secured so as not to be disturbed by the construction procedure. Tie bars shall not be placed mechanically or by hand into the plastic concrete during the paving operation unless approved by the Engineer. Tie bars shall not be located within one foot of an intersecting joint.

E. Placing, Finishing, Curing, and Protection: Concrete shall be furnished in quantities required for immediate use and shall be placed in accordance with the requirements of the applicable specification as stipulated in Section 2208.3.A. Prior to commencing construction, the Contractor shall furnish a concrete delivery plan which includes at a minimum the number of trucks which will be dedicated to the project, the location of the concrete plant, the route and distance from the plant to the job site, and the anticipated rate of concrete usage. It is essential that concrete be delivered in sufficient quantities to prevent stoppage of the paving operation.

1. Concrete Placement: The concrete shall be deposited on the subgrade to the required depth and width of the construction lane in successive batches and in a continuous operation without the use of intermediate forms or bulkheads. The subgrade shall be moistened prior to the placement of concrete. The concrete shall be placed as uniformly as possible in order to minimize the amount of additional spreading necessary. The concrete shall not be permitted to drop freely a distance of greater than 3 feet. While being placed, the concrete shall be vibrated and compacted with suitable tools so that the formation of voids or honeycomb pockets is prevented.

   The concrete shall be well vibrated and tamped against the forms and along all joints. Care shall be taken in the distribution of the concrete to deposit a sufficient volume along the outside form lines so that the curb section can be consolidated and finished simultaneously with the slab.

   No concrete shall be placed around manholes or other structures until they have been brought to the required grade, alignment, and cross slope.

   Concrete shall not be allowed to extrude below the forms.

   Limitations for time of placement and other items not specifically covered by this specification shall be in accordance with the most recent Standard Specifications of the State Department of Transportation

for the state the work is being performed in. The Engineer may extend placement time limitations based on field conditions and concrete consistency and workability.

2. Concrete Finishing Methods: The pavement shall be struck off and consolidated with a mechanical finishing machine. Hand finishing methods may be used for small or irregular areas. Furnish paving and finishing equipment applicable to the type of construction as follows:

   a. Slip-form Machines: Furnish slip-form machines capable of spreading, consolidating, screeding, and float finishing the freshly placed concrete in one pass to provide a dense and homogeneous pavement with minimal hand finishing.
   b. Self-Propelled Form-Riding Machines: Furnish mechanical, self-propelled spreading and finishing machines capable of consolidation and finishing the concrete with minimal hand finishing. Do not use machines that displace the fixed side forms.
   c. Manual Fixed-Form Paving Machines: Furnish spreading and finishing machines capable of consolidating and finishing the concrete with minimal hand finishing.
   d. Hand Methods: When finishing by hand methods, concrete shall be consolidated by use of vibrating units operating in the concrete. Unless the vibrating apparatus is such that the full width of concrete is consolidated in a single passage, a definite system or pattern shall be used in the operation of the vibrator so the full width of concrete in each linear foot of lane will receive adequate and uniform consolidation. The system and methods of vibrating shall be subject to approval of the Engineer. Vibrating equipment shall, under no circumstances, be used as a tool for moving concrete laterally on the grade.

3. Concrete Finishing

   a. Do not apply moisture (water, finishing aids, etc.) to the surface of the concrete pavement. The concrete should be provided with proper consistency and workability to place, strike off, consolidate, finish and texture without the addition of moisture. Only in the event of exceptional and unusual circumstances may the Engineer consider allowing a fine, fog mist to be added.
   b. Floating: All surfaces shall be consolidated and floated after strike-off and prior to final surface finish.
   c. Straightedging: Following the floating and while the concrete is still plastic, the surface shall be tested for trueness with a 10-foot straightedge placed parallel to the centerline and operated across the entire width of the pavement. The straightedge shall be advanced in successive stages not to exceed half its length and the operation repeated. Surface deviations greater than 1/8 inch shall be corrected and the straightedging repeated. Straightedging may be eliminated if the pavement smoothness is verified using a profilograph as specified in Section 2211.
   d. Edging: Before final finishing is completed and before the concrete has taken its initial set, the edges of the slab and curb shall be finished to 1/8” radius, or that shown on the Plans or Standard Drawings by the paving equipment, or with hand edging tools.
   e. Final Surface Finish
      i. Dragged Surface Treatment: For roadways with a design speed of 45 mph or less to be posted at 45 mph or less, astroturf or burlap shall be dragged longitudinally over the finished surface to produce a tight, uniform, textured surface, and the edges shall be rounded in a workmanlike manner.

         For roadways to be posted at 50 mph or more, astroturf or burlap shall be dragged longitudinally over the finished surface to produce a tight, uniform, textured surface, and the edges shall be rounded in a workmanlike manner. The texture achieved by

the astroturf or burlap drag shall be tested by the Contractor in accordance with ASTM E 965, "Test Method for Measuring Surface Macrotexture Depth Using a Sand Volumetric Technique", to ensure the texture is adequate for skid resistance. Test locations will be determined by the Engineer. The results of ASTM E 965 shall show an average texture depth of any lot, as defined below, and shall have a minimum value of 0.032 inch. Any lot showing an average of less than 0.032 inch but equal to or greater than 0.024 inch will be accepted as substantial compliance but the Contractor shall amend their operation to achieve the required 0.032 inch minimum depth. (It is not the intention of this tolerance to allow the Contractor to continuously pave with an average texture depth of less than 0.032 inch). Any lot showing an average texture depth of less than 0.024 inch shall require diamond grinding of the pavement represented by this lot to attain the necessary texture. Any *individual test* showing a texture depth of less than 0.020 inch shall require diamond grinding of the pavement represented by this lot to attain the necessary texture. Limits of any failing individual test shall be determined by running additional tests at 100 foot intervals before and after the failing test location. All testing of the surface texture shall be completed no later than the day following pavement placement.

ii. Groove Treatment: For roadways to be posted at 50 mph or more, the surface of the traveled lanes shall be grooved in a transverse direction unless specified otherwise in the Plans, Special Provisions, or Specifications. If approved by the Engineer, a suitable longitudinal grooving or a dragged surface treatment as described in Section 2208.4.E.3.e.i may be used in lieu of the transvers grooving. Surface grooving shall be done with a mechanical device such as a wire broom or comb or by hand. The broom or comb shall have a single row of spring steel tines, rectangular in cross section, 1/8 inch to 3/16 inch wide; spaced on 3/4 inch centers of sufficient length, thickness, and resilience to form grooves to a depth of a minimum of 1/8 inch and a maximum of approximately 3/16 inch in the plastic concrete. If grooves are to be installed by hand, the proposed equipment and process to be used shall be approved by the Engineer. This operation shall be done at such time and in such manner that the desired surface texture will be achieved while minimizing displacement of the larger aggregate particles and before the surface permanently sets. Where abutting pavement is to be placed, the grooving should extend as close to the edge as possible without damaging the edge. If abutting pavement is not to be placed, the 6 inch area nearest the edge or 1 foot from the face of the curb is not required to be grooved. For small or irregular areas or during equipment breakdown, grooving may be done by hand methods.

4. Curing: As soon as practical after the concrete is finished it shall be cured with an approved curing method. If a liquid curing membrane is used, it shall be white pigmented and applied in accordance to the manufacturer's directions.

   a. Method of Applying Curing Membrane: A nozzle producing a uniform fan pattern will be used on all spray equipment when applying the liquid curing membrane. The curing compound should be applied immediately after final finishing, and before the loss of all free water on the surface of the concrete. Normally one smooth, even coat shall be applied at a rate of 150 to 200 square feet per gallon, but two coats may be necessary to ensure complete coverage and effective protection. Second coats should be applied at right angles to the first.

   b. Curing Formed Surfaces: If the forms are removed from finished concrete pavement within a period of 72 hours or if a slip-form paving machine has been used, all exposed surfaces shall be cured. Curing membrane damaged by joint sawing operations shall be repaired by the Contractor as directed by the Engineer.

5. Protection: The Contractor shall, at his own expense, protect the concrete work against damage or defacement of any kind until it has been accepted by the Engineer. All vehicular traffic shall be prohibited from using the new concrete pavement until the following criteria have been met:

   a. Construction traffic: New concrete pavement may be opened to light construction traffic after a minimum of four (4) days of cure time has elapsed and the joints have been protected from the intrusion of foreign material by an approved method. The Contractor may reduce this length of time by one of these options, performed at the expense of the Contractor:
      i. Achieve a minimum compressive strength of 70% of the 28 day design strength as determined in accordance with ASTM C 39.
      ii. Achieve a minimum flexural strength of 350 psi using a third point loading method.
   b. All traffic: New concrete pavement may be opened to all traffic after a minimum of seven (7) days of cure time has elapsed and the joints have been sealed in accordance with Section 2208.4.D. The Contractor may reduce this length of time by one of these options, performed at the expense of the Contractor:
      i. Achieve a minimum compressive strength of 100% of the 28 day design strength as determined in accordance with ASTM C 39.
      ii. Achieve a minimum flexural strength of 450 psi using a third point loading method.

   Concrete pavement that is not acceptable to the Engineer because of damage or defacement shall be removed and replaced, or repaired, to the satisfaction of the Engineer, at the expense of the Contractor.

6. Pavement Smoothness: If required by the Contract Documents, pavement smoothness shall adhere to Section 2211. If not required by the Contract Documents, the Engineer shall determine areas to be checked for surface tolerance by the Contractor. The areas identified by the Engineer shall be checked with a 10 foot straightedge placed parallel to the center line at any location within a driving lane. Areas showing high spots of more than 1/4 of an inch in 10 feet shall be marked and ground down with approved grinding equipment to an elevation where the area or spot will not show surface deviations in excess of 1/8 inch when tested with a 10 foot straight edge. Grinding will be performed on the full width of the lane failing to meet the above criteria. The cost of correcting the smoothness and any other associated costs such as traffic control shall be at Contractor's expense.

7. Diamond Grinding: If required by the Contract Documents or if pavement smoothness criteria from Section 2208.4.E or Section 2211 are not achieved, the Contractor shall grind the riding surface to reduce or eliminate the irregularities.

   a. Use a self-propelled grinding machine with diamond blades mounted on a multi-blade arbor. Avoid using equipment that causes excessive ravels, aggregate fractures, or spalls. Provide uniform texture the full width of the lane.
   b. Transverse grooving will not be required.
   c. Use vacuum equipment or other continuous methods to remove grinding slurry and residue. Prevent the grinding slurry from flowing across lanes being used by traffic or into streams, lakes, ponds or other bodies of water, inlets, storm sewer or other drainage system.
   d. After corrections have been made to the riding surface, test the pavement for smoothness using the same technique used to determine smoothness originally. Furnish and operate the smoothness measurement equipment, and evaluate the results as specified in Section 2211.
   e. Perform additional grinding as required to attain the required smoothness. Correct all deviations (in excess of 1/2 inch in a length of 25 feet or ¼ inch in a length of 10 feet) within each section regardless of the profile index value.

8. Temperature Limitation: Concrete work shall be in accordance with the requirements of the state DOT specifications for the state where the work is being performed.

9. Backfill: A minimum of 24 hours shall elapse before forms are removed and 5 days shall elapse or the concrete must have attained 75% of its 28 day compressive strength before pavement is backfilled unless otherwise approved by the Engineer.

10. Backfill shall be accomplished in accordance with Sections 2100 and 2201 entitled "Grading and Site Preparation" and "Subgrade Preparation".

11. The Contractor shall be responsible for the repair of any existing street pavement damaged by the construction to the satisfaction of the Engineer.

12. Joint Sealing and Cleanup: All joints shall be sealed with an approved joint sealer meeting the requirements of Section 2208.3 applied in accordance with this section and the manufacturer's directions within 7 days of the placement of the concrete and prior to the opening of the pavement to traffic. If pavement design does not specifically require the use of joint sealant, prepare the joint as described on the Plans or in the specifications.

    The Contractor shall be responsible for the removal of excess dirt, rock, broken concrete, concrete splatters and overspray from the area of the construction.

2208.5 Integral Curb

If required by the Plans, Standard Drawings or Special Provisions, integral curbs shall be placed along the edges of all street pavement, except at such locations as the Engineer may direct.

The integral curb shall be constructed during or immediately following the finishing operation unless otherwise shown on the Plans. Special care shall be taken so that the curb construction does not lag behind the pavement construction and form a "cold joint".

Steel curb forms or integral slip-forming shall be required to form the backs of all curbs except where impractical because of small radii street returns or other special sections.

Concrete shall be consolidated with an approved vibrator.

Curbs shall be finished to the cross-section as shown on the Plans with a mule; or templates supported on the side forms and with a float not less than four feet in length, unless another method is approved by the Engineer.

The finished surface of the curb and gutter shall be checked for no more than 1/4 inch deviation by the use of a 10 foot straightedge and corrected if necessary.

Where grades are flat and while the concrete is still plastic, the flowline of the gutter should be checked by the Contractor to verify positive drainage.

Finishing, edging, curing, protection, jointing, temperature limitations and backfill shall all comply with Section 2208.4. The curb shall have a brush or broom finish.

2208.6 Repairing Defects

Any defect occurring prior to final acceptance of the project or the end of a Contract warranty period shall be repaired by removing and replacing the affected area to the nearest joint, or as directed by the Engineer. After project final acceptance or expiration of the warranty period, repair defects in conformance with the following. Do not begin corrective work until after submitting a plan and receiving the Engineer's approval for repair methods.

Defect Type	Defect Direction	Defect Location	Description	Repair Procedure	Alternate Procedure
Plastic Shrinkage Crack	Any	Anywhere	Only partially penetrates depth	Do nothing	Fill with HMWM2
Uncontrolled Crack	Transverse	Mid-slab	Full-depth	Saw and seal crack	LTR3
Uncontrolled Crack	Transverse	Crosses or ends at transverse joint	Full-depth	Saw and seal the crack; Epoxy uncracked joint	
Uncontrolled Crack	Transverse	Relatively parallel and within 5 ft of joint	Full-depth	Saw and seal the crack; Seal joint	FDR4 to replace crack and joint
Saw cut or Uncontrolled Crack	Transverse	Anywhere	Spalled	Repair spall by PDRS if crack not removed	
Uncontrolled Crack	Longitudinal	Relatively parallel and within 1 ft of joint; May cross or end at longitudinal joint	Full-depth	Saw and seal crack; Epoxy uncracked joint	Cross stitch crack
Uncontrolled Crack	Longitudinal	Relatively parallel and in wheel path 1-4.5 ft (from joint)	Full-depth, hairline or spalled	Remove and replace slab	Cross stitch crack
Uncontrolled Crack	Longitudinal	Relatively parallel and further than 4.5 ft from a long joint or edge	Full-depth	Cross-stitch crack; Seal longitudinal joint	
Saw cut or Uncontrolled Crack	Longitudinal	Anywhere	Spalled	Repair spall by PDRS if crack not removed	
Uncontrolled Crack	Diagonal	Anywhere	Full-depth	FDR4	
Uncontrolled Crack	Multiple per Slab	Anywhere	Two cracks dividing slab into 3 or more pieces	Remove and replace slab	

HMWM = High molecular weight methacrylate poured over surface and sprinkled with sand for skid resistance.
LTR = Load-transfer restoration; 3 dowel bars per wheel path grouted into slots sawed across the crack; Slots must be parallel to each other and the longitudinal joint.
FDR = full-depth repair; 10 ft long by one lane wide. Extend to nearest transverse contraction joint if 10 ft repair would leave a segment of pavement less than 10 ft long.
PDR = partial-depth repair; Saw around spall leaving 2 in between spall and 2 in deep perimeter saw. Chip concrete free, then clean and apply bonding agent to patch area. Place a separating medium along any abutting joint or crack. Fill area with patching mixture.
Cross-stitching: for longitudinal cracks only, drill ¾" holes at 35° angle, alternating from each side of joint on 30-36 inch spacing. Epoxy #5 epoxy coated deformed steel tie-bars into hole.

2208.7 Method of Measurement

Portland Cement Concrete Pavement will be measured per square yard or tenth part thereof for the specified depth.

2208.8 Basis of Payment

Portland Cement Concrete Pavement will be paid for by one of the following:

A. Contract unit bid price.

B. Contract lump sum bid price.

SECTION 2209 CURBING

2209.1 Scope

This section governs the furnishing of all labor, materials and equipment for the construction or reconstruction of curbing as shown on the Plans and in accordance with the Standard Drawings, the specifications, and the Special Provisions.

2209.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

ASTM
D 698 Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))

2209.3 Materials

All Materials shall conform to Section 2208.3. Materials submittals and testing shall conform to Section 2208.

2209.4 Construction

The curbing shall be constructed or reconstructed to the configuration and to the lines and grades shown on the Plans.

A. Removal of Existing Curbing for Reconstruction: Existing curbing shall be totally removed to the nearest contraction or expansion (isolation) joint or with the approval of the Engineer it may be sawed provided no free section is left that is less than 5 lineal feet in length, and provided the entire curbing section is sawed a minimum of 2 inches below any exposed surface, or sufficiently to prevent disturbance or damage to all adjacent structures or slabs, whichever is greater.

B. Grading and Subgrade Preparation: All excavation or embankment shall conform to Sections 2100 and 2201 entitled "Grading and Site Preparation" and "Subgrade Preparation".

Compaction shall conform to Section 2201.4.B.

C. Forms: All forms shall be in good condition, clean, and free from imperfections. Each form shall not vary more than 1/4 inch in horizontal and vertical alignment for each 10 feet in length. Face forms will be used when feasible. Forms shall have a height equal to or greater than the height of the curb face being formed. The forms shall be set true to line and grade and shall be supported to stay in position while depositing and

consolidating the concrete. The forms shall be designed to permit their removal without damage to the concrete. The forms shall be lubricated.

D. Slip-Form Curb Machine: A slip-form curb machine may be used in lieu of forms. The machine must be equipped with mechanical internal vibrators and be capable of placing curb to the correct cross section, line and grade within the allowable tolerances.

E. Joints: The joints shall be formed at right angles to the alignment of the curbing and to the depths specified by the appropriate Standard Drawing or as shown on the Plans. Joints should be aligned with concrete pavement joints where feasible.

1. Isolation Joints: Isolation joints shall be placed at all radius points, driveways, curb inlets, or where directed by the Plans or Engineer.

    a. Material: Isolation joints shall be formed by a one piece, one inch thick preformed joint filler cut to the configuration of the correct curb section, and conforming to Section 2208.3.D.
    b. Stability: Isolation joints shall be secured in a manner so they will not be disturbed by depositing and consolidating of concrete.
    c. Edging: The edges of the joints shall be rounded with an edging tool of 1/4 inch radius.

2. Contraction Joints: Curbing shall have contraction joints at intervals of not less than 10 feet or more than 15 feet. They shall extend through the entire curb section from the top of the curb to a depth 2 inches below pavement surface.

    a. Method: Contraction joints shall be formed or sawed.
        i. When sawing joints, the contractor shall begin as soon as the concrete hardens sufficiently to prevent excessive raveling along the saw cut and shall finish before conditions induce uncontrolled cracks, regardless of the time or weather. When joint sealing backup material is specified with sawed joints, the first stage, which provides a relief cut shall be approximately 1/8 inch wide, and shall be to Plan depth. The second stage which widens the joints to allow the insertion of joint sealing backup material to Plan depth shall not be performed until the concrete is at least 48 hours old, and shall be delayed longer when the sawing causes raveling of the concrete. If second stage sawing is performed prior to the completion of the curing period, the Contractor shall maintain the cure by use of curing tapes, plastic devices, or other materials approved by the Engineer.
        ii. When forming joints, templates shall be 1/8” metal cut to the configuration of the curbing section. The templates shall be secured at the proper locations so that they will not be disturbed by the depositing of concrete. The templates shall be removed as soon as the concrete has attained its initial set and finished with a ¼ inch radius on all exposed edges.
    b. Joint Sealer: When specified, joint sealants shall conform to Section 2208.3.

F. Concrete Work: Concrete for curbing shall be placed in accordance with the requirements of Section 2208.4. Isolation and contraction joints shall be constructed as shown on the Plans, Standard Drawings, or where directed by the Engineer.

1. Concrete Placement: Concrete shall be mechanically vibrated and shall not be allowed to extrude below the forms to cause an irregular alignment of the abutting street pavement.

2. Finishing: After placing and initial strike-off the curb shall be tooled to the required radii. If the surface

of the concrete is sufficiently wet that a ridge is formed at the inside of the radius tool, finishing will cease until the excessive moisture has evaporated.

After initial set, the face forms shall be removed and the surface finished to the required dimensions. No water, dryer, or additional mortar shall be applied to the free surface of the concrete.

The finished surface of the concrete shall be broomed perpendicular to the curb with a clean broom to provide an antiskid surface.

In all cases the finished curb shall have a true surface, free from sags, twists, or warps, and shall have a uniform color and appearance.

3. Curing: As soon as practical after the concrete is finished it shall be cured with a liquid curing membrane meeting the requirements of Section 2208.4.E.4, applied according to the manufacturer's directions.

   If front and/or back forms are removed from finished curbing within a period of 72 hours of placement these surfaces shall also be cured.

   Wet burlap, cotton mat, waterproof paper, polyethylene sheeting or earth backfill is not an acceptable curing method for curbing.

4. Protection: The Contractor shall protect the concrete work against damage or defacement of any kind until it has been accepted by the Engineer. Concrete which is damaged or defaced, shall be removed and replaced, or repaired to the satisfaction of the Engineer, at the expense of the Contractor.

5. Temperature Limitations: Concrete work shall be performed in accordance with requirements of the state DOT specifications for the state where the work is being performed.

6. Backfill: Backfill shall conform to Section 2208.4.E.9. The Contractor shall be responsible for the repair of any pavement disturbed by the construction to the satisfaction of the Engineer.

7. Joint Sealing and Clean-Up: Unless otherwise specified or waived by the Engineer, an approved joint sealer shall be applied in accordance with the manufacturer's directions within 7 days of the placement of the concrete. The Contractor shall be responsible for the removal of excess dirt, rock, broken concrete, concrete splatters and overspray from the area of the construction.

8. Surface Tolerances: Curbing shall have a surface tolerance of 1/4 inch in 10 feet when checked with a ten foot straightedge.

9. Repairing Defects: Defects in the concrete shall be repaired in accordance with Section 2208.6.

2209.5 Method of Measurement

Curbing will be measured per lineal foot or tenth part thereof for the applicable type.

2209.6 Basis of Payment

Curbing will be paid for by one of the following:

A. Contract unit bid price.

B. Contract lump sum bid price.

SECTION 2210

This section has been intentionally left blank.

SECTION 2211 SMOOTHNESS

2211.1 Scope

This section governs the furnishing of all labor, materials and equipment for the determination of pavement surface smoothness, evaluation of results, and corrective actions as shown on the Plans and in accordance with the Contract Documents, Standard Drawings, the specifications and the Special Provisions.

2211.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

Kansas Department of Transportation
Standard Specifications for State Road and Bridge Construction, 2015 Edition
Kansas Test Method KT-46 from KDOT Construction Manual, latest revision

Missouri Highways and Transportation Commission
Missouri Standard Specifications for Highway Construction, 2011 Edition
MoDOT Engineering Policy Guide Section 106.3.2.59 TM-59, Determination of the International Roughness Index

2211.3 Equipment

Equipment for determination of pavement smoothness and performance of corrective actions shall be in compliance with the specifications of the Department of Transportation of the state where the work is performed; for MoDOT, Section 502.8 and for KDOT, Sections 503 and 603.

2211.4 Construction

If specified in the Contract Documents, profilographing shall be performed on roadways classified as arterials, major collectors, freeways, expressways and interstates.

A. Exceptions: Unless otherwise specified in the Contract Documents, profilographing will not be required for local roads or minor collectors. In addition, other exceptions shall be as specified in the state DOT specifications for the state the work is being performed in.

1. Finished pavements on local roads, minor collectors and other areas exempted from profilographing shall be checked with a 10 foot straightedge placed parallel to the center line at any location within a driving lane. Areas showing high spots of more than 1/4 of an inch in 10 feet shall be marked and ground down with approved grinding equipment to an elevation where the area or spot will not show surface deviations in excess of 1/8 inch when tested with a 10 foot straight edge. Grinding will be

performed on the full width of the lane failing to meet the smoothness criteria. The cost of correcting the smoothness and associated traffic control shall be at Contractor's expense.

B. Profilographing: Profilograph testing and evaluation shall be performed in accordance with the State Department of Transportation specifications and test methods for the state where the work is being performed; for MoDOT, Section 502.8 and for KDOT, Sections 503 and 603. Within two days after the paving, furnish the Engineer with the profilogram and its evaluation.

C. Corrective Actions: Corrective actions shall be performed at the Contractor's expense and in accordance with the State Department of Transportation specifications for the state where the work is being performed; for MoDOT, Section 502.8 and for KDOT, Sections 503 and 603.

D. Final Report: The Contractor shall submit a final report to the Engineer with final profilograph results verifying compliance with the specified pavement smoothness requirements.

E. Pay Adjustments: No pay adjustments (incentive or disincentive) shall be made to the smoothness or pavement items based on the results of the profilograph testing.

2211.5 Method of Measurement

Smoothness will be measured as a lump sum unit.

2211.6 Basis of Payment

Smoothness will be paid for by Contract lump sum bid price.

END OF SECTION

SECTION 2300 - INCIDENTAL CONSTRUCTION

CITY OF LEE'S SUMMIT, MISSOURI
STANDARD SPECIFICATIONS

The City of Lee's Summit hereby adopts Section 2300 of the Kansas City Metropolitan Chapter of APWA Construction and Material Specifications, current edition. The following additions, deletions and/or revisions are adopted as a part of Section 2300 for use within Lee's Summit. Text in bold italics indicates revisions or additions to the APWA standard.

2301.3 Materials

2301.3.A Concrete:

Concrete shall be a currently approved KCMMB 4k mix.

2301.3 Materials
ADD the following:

F. ADA Detectable Warning Surfaces: The material used to provide contrast shall be an integral part of the walking surface. The material for detectable surface shall be:

1. Grouted-in-Place Clay Pavers

a. Paving brick shall be 2 ¼" x 3 5/8" x 7 5/8" and shall meet the requirements of ASTM C902 for Class SX, Type 1 brick and ASTM C1272.

b. The bricks shall be placed in a Soldier Course pattern on type A and Type M ramps, or in the Herringbone or Soldier Course pattern on Type B ramps.

c. The bricks shall be saw cut only and any brick shall not be less than 25% of a full brick.

d. Type M mortar shall be used for the setting bed and grouted joints in accordance with ASTM C270, Table 1 (Masonry Cement Type only).

2. Cast-in-Place Tiles: Acceptable products include ceramic composites, composites, reinforced concrete, or materials of strength and durability similar to that of the concrete walking surface. Proposed materials shall be approved by the City prior to installation.

3. ***Color for all surface options shall be 'brick red' (Federal Standard Color No. 22144). Any color variation to meet contrast requirements must be approved by the City.***

4. ***Surface applied retrofit tiles shall not be allowed.***

G. Stamped and Colored Concrete:

1. ***Color shall be Federal Standard Color No. 30108 (Red Brown).***
2. ***Refer to LS Section 2400 Appendix A for stamped concrete additional material requirements, material approval process, mock ups, and installation.***

2302 Asphalt Sidewalks, Driveways, and Bicycle/Pedestrian Paths
ADD the following statement to Paragraph 2302.1

Scope: ***Asphalt shall not be allowed for sidewalks, driveways and bicycle/pedestrian paths within the public right-of-way.***

Section 2304 Concrete Paver Stones (for Median Treatment)

2304.3 Material: ADD the following1.3.A Concrete:

Stamped and colored concrete shall be used for medians and edge treatments along arterial streets. Interlocking paver stones will not be allowed for such use along arterial streets.

2305 Maintenance of Traffic: Delete APWA section in its entirety (replace with LS Section 3000 – Traffic Control, Marking and Signing)

2306 Pavement Markings: Delete APWA section in its entirety (replace with LS Section 3000 – Traffic Control, Marking and Signing).

SECTION 2300- INCIDENTAL CONSTRUCTION

APPENDIX for STAMPED CONCRETE CONSTRUCTION

SECTION 1 – GENERAL

1.1 Scope

This guide addresses the equipment, materials, and processes necessary for decorative concrete construction. It includes preparation of subgrade and surface profiling where necessary. It is to be used in conformance with job specific plans, specifications and other contract documents in endless applications.

1.2 Additional Technical Reports & References

A. American Concrete Institute (ACI) (www.concrete.org)

ACI 303 Architectural Cast-in-Place Concrete
ACI 308 Curing Concrete
ACI 310 Decorative Concrete
ACI 610D Decorative Concrete Finisher Certification Committee

B. American Society for Testing & Materials (ASTM) (www.ASTM.org)

ASTM C29 Test for Bulk Density (Unit Weight) & Voids in Aggregate
ASTM C138 Test Method for Density (Unit Weight), Yield and Air Content (Gravimetric) of Concrete
ASTM C172 Practice for Sampling Freshly Mixed Concrete (air content, composite sample, slump, temperature, wet sieving, etc.)
ASTM C309 Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C1315 Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete
ASTM C979 Standard Specification for Pigments for Integrally Colored Concrete

C. Kansas City Metropolitan Materials Board (www.kcmmb.org)

D. American Society of Concrete Contractors (ASCC) (www.ASCConline.org)
Decorative Concrete Council's Problems & Practice Series #1-8, DCC Decorative Concrete Insights & Tips

SECTION 2 - QUALIFICATIONS/MATERIALS/MOCK UPS/MIX DESIGNS/QUALITY/PRE CONSTRUCTION/CURING & SEALING

2.1 Contractor Qualifications: 2-3 years verifiable minimum experience in the concrete business, to include decorative concrete work.

2.2 Mix Design: Mix shall be KCMMB 4k Mix. Colorant shall be integral to the mix and not surface applied powder, epoxy, or other surficial coloring methods.

2.3 Mock Up/Field Test

1. For accurate color, the quantity of concrete mixed to produce the sample should not be less than 3 cubic yards and should always be in full cubic yard increments. Excess material should be discarded according to local regulations.
2. Construct a mock up on location at the jobsite, selected by the decision maker. Size of the mock up will be relevant to the scope of the project and showing all the different decorative colors/designs and patterns to be used in the final project.
2. Construct mockup using processes, materials and techniques intended for use on permanent work, including curing procedures. Include samples of control, construction, and expansion joints in sample panels. Mockup shall be produced by the individual workers who will perform the work for the project.
3. Written acceptance shall be provided of mock from the Owner to the Contractor shall be kept on record.
4. Accepted mock ups shall be kept on site to provide visual reference for comparison during project. Mockups shall remain through completion of the work for use as a quality standard for finished work.

2.5 Pre Construction Conference

1. To be conducted at least two weeks prior to the placement.
2. Attendance shall be mandatory for the sub contractor, ready mixed producer, contractor, engineer, and owner.

2.6 Curing & Sealing

1. Curing is a critical factor for success when using integral pigments in concrete. When a curing method or product has been selected a representative jobsite sample or mock up panel should be prepared in advance to demonstrate the effects that the curing method may have on the color and finish.
2. Any curing method or product chosen must comply with ASTM C-309 and or ASTM C-1315. Apply curing to the manufacturer's instructions using manufacturer's recommended application techniques. Apply curing compound at a consistent time for each pour to maintain close color consistently.
3. Make sure the curing agent and the sealing agent are compatible with each other.
4. Precautions shall be taken in hot weather to prevent plastic cracking resulting from excessively rapid drying at surface as described in CIP 5 Plastic Shrinkage Cracking published by the National Ready Mix Concrete Association.
5. Do not cover decorative concrete with plastic sheeting.
6. Curing References: ACI 305, ACI 306, ACI 308
7. Typical methods:
    a. Membrane forming cures – (use only when subsequent treatment interaction with concrete paste or concrete matrix penetration is not required)
        i) Water based
        ii) Solvent based

iii) Pigmented curing membranes
iv) Wax based

b. Dissipating curing membranes (water or wax based) - (use only when subsequent treatment interaction with concrete paste or concrete matrix penetration is not required or surface is to be mechanically abraded prior to subsequent treatments.)
c. Physical curing membranes or fabrics: Cold weather blankets or properly designed and applied curing blankets can be effective but must be demonstrated not to have a deleterious effect on color. Curing method shall be demonstrated on mock-up.

10. Curing considerations
    a. Type of finish
    b. Potential exposure to elements
    c. Potential Exposure to freeze/thaw
    d. Differential curing or slab discoloration
    e. Potential for efflorescence
    f. Release agent present
    g. Subsequent treatments or methods or post placement finishing such as polishing or staining
11. Surface applied evaporation retarder or monomolecular films are often used during placement and finishing to help hold moisture from the mix in place and slow hydration. Although this helps reduce plastic shrinkage cracks and rapid hydration, it is not considered a replacement for curing, but rather a supplemental treatment in hot weather conditions.
12. Sealing exterior flatwork is highly recommended to help protect the slab from freeze/thaw damage.

SECTION 3 - COLOR CONSISTENCY

3.1 Identifying What Can Effect Color Inconsistencies

1. Batch procedures / consistency
2. Use of supplementary cementitious materials (fly ash, slag etc.)
3. Changing suppliers midstream during a project
4. Curing methods
5. Efflorescence
6. Excess use of water
7. Finishing practices
8. Jobsite Addition of Water
9. Standing water / saturated subgrade
10. Subgrade preparation
11. Use of chloride containing admixtures
12. Variation in cement content
13. Variations in W/C ratios (Reread 2.4 Quality #1)

(continued on next page)

SECTION 4 – General Installation

4.1 General concrete placement, weather protection, and jointing shall follow APWA 2301.4.

4.2 Expansion joints shall be placed (a) every 100 feet, or (b) at changes in width and radius points. Also note that joints need to line up with paving joints.

4.2 Expansion joints shall be placed (a) every 100 feet, or (b) at changes in width and radius points. Also note that joints need to line up with paving joints.

4.4 Transverse joints shall be aligned with transverse joints in adjacent concrete curb, concrete sidewalks, or concrete pavements.

DIVISION II
CONSTRUCTION AND MATERIAL SPECIFICATIONS SEWERS
SECTION 2300 – INCIDENTAL CONSTRUCTION

APPROVED AND ADOPTED THIS 15th DAY OF FEBRUARY, 2017

KANSAS CITY METROPOLITAN CHAPTER
OF THE AMERICAN PUBLIC WORKS ASSOCIATION

TABLE OF CONTENTS

2301 STANDARD SIDEWALKS, SIDEWALK RAMPS, DRIVEWAYS, AND BICYCLE /PEDESTRIAN PATHS

2301.1 Scope

This section governs the furnishing of all labor, materials and equipment for the construction or reconstruction of sidewalks, sidewalk ramps driveways, and bicycle/pedestrian paths as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2301.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

ADAAG – ADA Accessibility Guidelines
Section 4.7 – Curb Ramps

PROWAG - Public Rights-of-Way Accessibility Guidelines

ASTM

A 615	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
A 775	Standard Specification for Epoxy-Coated Steel Reinforcing Bars
A 1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
C 31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
C 39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
C 143	Standard Test Method for Slump of Hydraulic-Cement Concrete
C 172	Standard Practice for Sampling Freshly Mixed Concrete
C 231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
C 309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
C 920	Standard Specification for Elastomeric Joint Sealants
C 1064	Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
D 1751	Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
D 1752	Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
D 2805	Standard Test Method for Hiding Power or Paints by Reflectometry
D 7174	Standard Specification for Preformed Closed-Cell Ployolefin Expansion Joint Fillers for Concrete Paving and Structural Construction

AASHTO

M 148	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

MCIB Mid-West Concrete Industry Board Concrete Specifications - Concrete Pavement.
The current editions of the "Bulletins" and Approved Sections of the "Standard Concrete Specifications" issued by the Mid-West Concrete Industry Board, Inc. (MCIB) are made a part hereof by reference. However, when the provisions of this Specification differ from the provisions of such "Bulletins" and "Sections" the provisions of this Specification shall govern. Reference December 2000 Specifications if most recent version does not contain specified mix designs.

KCMMB Kansas City Metro Materials Board Specifications

Kansas Department of Transportation
Standard Specifications for State Road and Bridge Construction, 2015 Edition

Missouri Highways and Transportation Commission
Missouri Standard Specifications for Highway Construction, 2011 Edition

2301.3 Materials

A. Concrete: Concrete shall conform to referenced specifications as called out in the Contract Documents. If no direct reference to concrete specifications is included in the Contract Documents, concrete shall meet KCMMB specifications.

1. If KCMMB concrete is specified, an approved KCMMB concrete mix shall be required.

2. If MCIB concrete is specified, concrete shall comply with MCIB Section entitled “Concrete Pavement”.

3. If KDOT specifications are referenced for concrete, provide material in compliance with the latest version of KDOT specifications. Approval of component materials will be based on submittal of certifications from supplier. Aggregates shall meet the quality requirements specified by KDOT. Engineer reserves the right to perform testing of components to verify compliance.

4. If MoDOT specifications are referenced, provide material in compliance with the latest version of MoDOT specifications. Approval of component materials will be based on submittal of certifications from supplier. Aggregates shall meet the quality requirements specified by MoDOT. Engineer reserves the right to perform testing of components to verify compliance.

5. Proposed concrete mix designs for use on the project shall be submitted to Engineer for approval at least two (2) weeks in advance of anticipated use. Mix design shall be approved prior to use of that mix.

6. Field testing of concrete shall be at the Contractor’s expense and performed by an ACI certified materials testing firm acceptable to the Owner. Unless otherwise specified, the following tests shall be performed once for every 50 cuyd of concrete placed:

    a. Sampling of fresh concrete per ASTM C 172
    b. Slump per ASTM C 143
    c. Air Content per ASTM C 231
    d. Temperature per ASTM C 1064
    e. Cylinders cast per ASTM C 31 and tested per ASTM C 39. Four cylinders shall be cast with one tested at 7 days, 2 tested at 28 days and one held in reserve.

B. Reinforcement: Reinforcement is not required unless shown on the Plans, Standard Drawings or in the Special Provisions. If specified to be used, reinforcement shall meet the following requirements:

1. Bars: Non-epoxy coated bars shall conform to ASTM A 615. Epoxy coated bars shall conform to ASTM A 775.

2. Welded Steel Wire: Welded steel wire fabric shall conform to ASTM A 1064.

3. Supporting Elements: Representative samples of supporting elements shall be submitted and approved by the Engineer prior to their use in the project.

4. Fibers: When specified in the Contract Documents, fibers shall be incorporated into the concrete at the rate recommended by the manufacturer but no less than a minimum of 3 pounds per cubic yard of concrete for macro fibers and 1 pound per cubic yard of concrete for micro fibers. Fibers shall meet the requirements of KDOT Standard Specifications for State Road and Bridge Construction, 2015 Edition, Section 1722.2. Micro fibers are used to control plastic shrinkage cracks in concrete while macro fibers control cracking in hardened concrete and are often used as a substitute for traditional crack control steel reinforcing bars or mesh. In addition, macro fibers add toughness, and impact and fatigue resistance to hardened concrete.

C. Isolation Joint: Isolation joints shall be formed by a one piece, 1/2-inch thick non–extruding preformed joint filler cut to the configuration of the abutting section. The filler material shall be full depth, and shall conform to ASTM D 1751, D 1752, or D 7174. ASTM D 1752 material shall be used against curved surfaces, around utility boxes or poles, or against other irregular surfaces, and may be used for all other applications.

D. Joint sealer shall meet the requirements of Section 2208.3 or may be an approved one-component, moisture-curing, non-priming, gun-grade, elastomeric polyurethane joint sealant that meets the requirements of ASTM C 920, Type S, Grade NS, Class 25, Use NT and M.

E. Curing Membrane: All material to be used or employed in curing Portland Cement Concrete must be approved by the Engineer prior to its use. It shall be of the liquid membrane type and shall conform to ASTM C 309, Type II, Class A or B or AASHTO M 148, Type 2, white pigmented.

2301.4 Construction

The sidewalks, sidewalk ramps, driveways or bicycle/pedestrian paths shall be constructed or reconstructed to the configuration, and to the lines and grades shown on the Plans. Generally sidewalks, sidewalk ramps, driveways, and bicycle/pedestrian paths should be constructed after the curbing. Sidewalk ramp construction shall comply fully with all requirements for sidewalks in this section and shall comply with the requirements of ADAAG Section 4.7 and the most current federal guidelines governing sidewalk ramps (i.e. PROWAG).

A. Removal: Existing sidewalks, sidewalk ramps, driveways, or bicycle/pedestrian paths shall be totally removed to the nearest contraction or isolation joint, unless otherwise specified by the Engineer. The section shall be sawed full depth.

B. Grading, Subgrade Preparation and Base Course: All excavation, embankment, subgrade stabilization or aggregate base course required shall be as defined in Sections 2100 “Grading and Site Preparation”, 2201 "Subgrade Preparation", 2202 “Subgrade Stabilization”, and 2203 “Aggregate Base Course”, except as follows:

1. Unless otherwise specified on the Plans, Standard Drawings or Special Provisions, the subgrade shall be compacted until no further consolidation of the material occurs using compaction methods approved by the Engineer. The Engineer will visually determine the acceptance of the subgrade. Satisfactory moisture content shall be achieved to provide sufficient compaction of material as approved by the Engineer.

If during reconstruction operations additional fill material is needed beneath sidewalks or driveways it shall be untreated compacted aggregate conforming to Section 2203.3.A, placed in conformance with Section 2203.4.A.

C. Forms: All forms shall be in good condition, clean, and free from imperfections. Each form shall not vary more than 1/4 inch in horizontal or vertical alignment for each 10 feet in length.

1. Material and Size: Forms shall be made of metal unless otherwise approved by the Engineer and shall have a height equal to or greater than the depth of the sidewalk, driveway, or bicycle/pedestrian path section. Wood forms may be substituted when approved by Engineer and if they are free from warp with sufficient strength for the intended application.

2. Strength: Forms shall be of such cross–section and strength, and so secured as to resist the pressure of the concrete when struck off, vibrated, and finished, and the impact and vibration of any equipment which they may support.

3. Installation: The forms shall be set true to line and grade, supported through their length and joined neatly in such a manner that the joints are free from movement in any direction.

4. Preparation: Forms shall be cleaned and lubricated prior to each use and shall be so designed to permit their removal without damage to the new concrete.

D. Slip–form Machine: A slip–form machine may be used in lieu of forms. The machine must be equipped with mechanical internal vibrators and be capable of placing concrete to the correct cross section, line and grade within the allowable tolerances.

E. Grades and Slopes: The grade and slope along the length of the walk shall conform to the most current version of PROWAG. Unless shown otherwise on the Plans or directed by the Engineer, the cross slope shall be toward the street. The sidewalk cross slope shall be carried through driveways.

F. Joints: Unless directed by the Engineer the joints shall be formed at right angles to the alignment of the sidewalk, driveway, or bicycle/pedestrian path and to the configuration specified by the Plans or Standard Drawings.

1. Joint Patterns

   a. Sidewalk surfaces shall be marked with a transverse joint spaced at a distance equal to the width of the sidewalk. Sidewalks greater than 6 feet in width shall be divided by longitudinal joints spaced not less than 30 inches nor more than 60 inches with transverse joints spaced to form a square pattern. Edger tool marks shall remain showing unless the sidewalk is slip–formed and subsequently sawed. Curb joints should align with sidewalk joints where they abut.
   b. Concrete driveways and bicycle/pedestrian paths shall have a maximum slab dimension no greater than 10 feet, although widths no more than 24 times the slab thickness will be permitted to match existing joint patterns.

2. Isolation joints: Isolation joints shall be placed at locations shown on the Plans and Standard Drawings or as directed by the Engineer.

   a. General: The preformed isolation joint material shall be left 1/2-inch below the surface, or a suitable tear strip will be provided to allow for the application of the joint sealer.

b. Stability: Isolation joints shall be secured in a manner so they will not be disturbed by depositing and consolidating the concrete.
c. Edging: The newly poured edges of these joints shall be rounded with an edging tool of ¼ inch radius.
d. Spacing: Isolation joints shall be placed at spacing indicated on the Plans or Standard Drawings. Spacing should not exceed 100' from center to center.

3. Contraction joints: Contraction joints shall be 1-inch deep by 1/8-inch wide with 1/4-inch radii rounded edges.

a. Edging: Edger marks shall remain showing unless the sidewalk, driveway or bicycle/pedestrian path is slip formed and subsequently sawed.
b. Slip forming: Contraction joints may be sawed 1/8-inch wide by 1/3rd the thickness of the slab.
c. Joint Sealer: Joint sealer is not required, unless otherwise specified in the Plans, Standard Drawings or Special Provisions.

G. Concrete Work: Concrete shall be furnished in quantities required for immediate use and shall be placed in accordance with the requirements of the applicable specification as stipulated in Section 2208.3.A.

1. Concrete Placement: Deposit and consolidate concrete as close to the final position as possible, beginning at one corner of the forms. Perform necessary hand spreading with shovels or come–alongs, not with rakes or vibrators. All concrete shall be well vibrated unless approved otherwise by the Engineer. Do not walk in the fresh concrete with boots or shoes coated with earth or foreign substances. When concrete is placed on a sloped surface, begin concrete placement at the lowest area.

   Limitations for time of placement and other items not specifically covered by this specification shall be in accordance with the most recent Standard Specifications of the State Department of Transportation for the state the work is being performed in. The Engineer may extend placement time limitations based on field conditions and concrete consistency and workability.

2. Finishing

a. Strike off the concrete with a vibratory screed or a hand strike–off method when adequate consolidation is attained. Immediately after strike–off, the concrete may be bull-floated to remove any high or low spots. Minimize the use of the bull-float.
b. Do not finish concrete with water standing on the surface. All edges of the slab shall be carefully finished with a 1/4-inch radius edger.
c. After finishing, the surface of the concrete shall be broomed with a fine clean broom to provide an antiskid surface, and the edges and joints retooled unless slip-formed.
d. In all cases the finished sidewalk, driveway, or bicycle/pedestrian path shall have a true surface, free from sags, twists, or warps, and shall have a uniform color and appearance.

3. Curing: As soon as practical after the concrete is finished it shall be cured with an approved liquid curing membrane applied according to manufacturer's directions.

a. If forms are removed within a period of 72 hours of placement those formed surfaces shall also be cured.
b. Wet burlap, cotton mats, waterproof paper, polyethylene sheeting or earth backfill shall not be acceptable as curing methods.

4. Protection: The Contractor shall protect the concrete work against damage or defacement of any kind until it has been accepted by the Engineer. Concrete which is damaged or defaced shall be removed and replaced or repaired to the satisfaction of the Engineer, at the expense of the Contractor.

5. Temperature Limitations: Concrete shall be placed in accordance with requirements of the state DOT specifications for the state where the work is being performed.

H. Backfill: A minimum of 24 hours shall elapse before forms are removed and 5 days shall elapse or the concrete must have attained 75% of its 28 day compressive strength before pavement is backfilled unless otherwise approved by the Engineer.

I. Backfill shall be accomplished in accordance with Sections 2100 and 2201 entitled "Grading and Site Preparation" and "Subgrade Preparation".

J. The Contractor shall be responsible for the repair of any street pavement damaged by the construction to the satisfaction of the Engineer.

K. Joint Sealing and Clean–Up: All isolation joints shall be sealed with an approved joint sealer meeting the requirements of Section 2301.3.D applied in accordance with Section 2208.4 and the manufacturer's directions within 7 days of the placement of the concrete and prior to the opening of the pavement to traffic.

L. The Contractor shall be responsible for the removal of excess dirt, rock, broken concrete, splatters and overspray from the construction area within 10 days unless otherwise directed by the Engineer.

M. Surface Tolerances: Sidewalks, driveways, and bicycle/pedestrian paths shall have a surface tolerance of 1/4 inch in 10 feet when checked with a 10 foot straightedge. Vertical deflections at sidewalk joints shall not exceed 1/4-inch.

N. Detectable Warnings: Detectable warnings are required standardized surface features built in or applied to walking surfaces on sidewalks or ramps to warn visually impaired people of hazards on a circulation path. Those hazards include, but are not limited to interfaces between sidewalks and areas where moving vehicles may be present. Detectable warnings shall be in accordance with PROWAG Section R305.

2301.5 Method of Measurement

A. Sidewalks: Sidewalks will be measured per square foot or tenth part thereof.

B. Sidewalk Ramps: Sidewalk ramps including detectable warning will be measured by one of the following:

1. Per square foot or tenth part thereof. Street curbing adjoining sidewalk ramps will be measured in accordance with Section 2209.5 and paid for separately.

2. Per each.

C. Driveways: Driveways will be measured per square foot or tenth part thereof.

D. Bicycle/Pedestrian Paths: Bicycle/Pedestrian paths will be measured per square foot or tenth part thereof.

2301.6 Basis of Payment

All items in this section will be paid for by the Contract unit bid price.

SECTION 2302 ASPHALT SIDEWALKS, DRIVEWAYS, AND BICYCLE/PEDESTRIAN PATHS

2302.1 Scope

This section governs the furnishing of all labor, materials and equipment for the construction or reconstruction of asphalt sidewalks, driveways, and bicycle/pedestrian paths as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2302.2 Asphalt Sidewalks

Asphalt shall not be used in the construction of any approved permanent sidewalk. Asphalt may be used as material for temporary sidewalks if approved in advance by the Engineer.

2302.3 Asphalt Driveways

Asphalt driveways may be constructed with prior approval of the Engineer in accordance with the provisions of Section 2205 "Asphalt Paving" and Section 2209 "Curbing" as applicable.

2302.4 Asphalt Bicycle/Pedestrian Paths

Asphalt bicycle/pedestrian paths shall be constructed in accordance with the provisions of Section 2205 “Asphalt Paving” and in accordance with the applicable provisions of Section 2302.3.

2302.5 Method of Measurement

A. Asphalt Sidewalks: Asphalt Sidewalks will be measured by one of the following:

1. Per ton or tenth part thereof.
2. Per square foot or tenth part thereof.

B. Asphalt Driveways: Asphalt Driveways will be measured by one of the following:

1. Per ton or tenth part thereof.
2. Per square foot or tenth part thereof.

C. Asphalt Bicycle Pedestrian Paths: Asphalt Bicycle/Pedestrian paths will be measured by one of the following:

1. Per ton or tenth part thereof.
2. Per square foot or tenth part thereof.

2302.6 Basis of Payment

All items in this section will be paid for at the Contract unit bid price.

SECTION 2303 ROCK BLANKET

2303.1 Scope

This section governs the furnishing of all labor, materials and equipment for the construction of a protecting blanket of rock or broken concrete on slopes, channel bank or stream banks as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2303.2 Materials

The material for rock blanket shall be durable stone or broken concrete containing a combined total of not more than ten percent (10%) of earth, sand, shale, and non–durable rock. It is preferable that the material contain a large percentage of pieces as large as the thickness of the blanket will permit, with enough smaller pieces of various sizes to fill the larger voids. Acceptance of quality and size of material may be made by the Engineer using visual inspection at the job site. If broken concrete is used, all reinforcing shall be removed prior to placement.

Rock Blanket shall be specified by class as shown in the following tables:

Class	Percent Heavier Than									
	1 Ton	1/2 Ton	1/4 Ton	250 lbs	200 lbs	180 lbs	75 lbs	60 lbs	10 lbs	5 lbs
1 Ton	50+	95+								
1/2 Ton	0	50+	95+							
1/4 Ton		0	50+				90+			
Facing					0		50+			90+
Light 24			0		50+					90+
Light18				0		5–15		50–70	85–100	

2303.3 Construction

A trench at the toe of the slope shall be excavated to the elevation as shown on the Plans or to a minimum of 2-feet when not shown. The slopes shall conform to the proper cross section and be compacted to a uniform density as required for adjacent material. The rock or broken concrete shall be placed on the slope, to the prescribed thickness, elevation and extent, and shall be manipulated so that the flat sides are in contact, thereby eliminating large voids. The outside of the blanket shall present an appearance free from segregation and with a proportionate amount of the larger pieces showing.

2303.4 Method of Measurement

Rock blanket will be measured by one of the following:

A. Per square yard or tenth part thereof.

B. Per ton or tenth part thereof.

2303.5 Basis of Payment

Rock blanket will be paid for by the Contract unit bid price.

SECTION 2304 CONCRETE PAVER STONES (FOR MEDIAN TREATMENT)

2304.1 Scope

This section governs the furnishing of all labor, equipment and tools and for the performance of all work necessary to install concrete paver stones as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2304.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

ASTM

C 67 Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
C 140 Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
C 418 Standard Test Method for Abrasion Resistance of Concrete by Sandblasting
C 936 Standard Specification for Solid Concrete Interlocking Paving Units

MCIB Mid-West Concrete Industry Board Concrete Specifications - Concrete Pavement
The current editions of the "Bulletins" and Approved Sections of the "Standard Concrete Specifications" issued by the Mid-West Concrete Industry Board, Inc. (MCIB) are made a part hereof by reference. However, when the provisions of this Specification differ from the provisions of such "Bulletins" and "Sections" the provisions of this Specification shall govern. Reference December 2000 Specifications if most recent version does not contain specified mix designs.

KCMMB Kansas City Metro Materials Board Specifications

2304.3 Materials

A. Interlocking Concrete Paver Stones (ASTM C 936)

1. Paver stones shall be cobblestone style consisting of full stones, 4-5/8" x 7" x 2-3/8"; two thirds stones, 4-5/8" x 4-5/8" x 2 3/8"; and one third stones, 4-5/8" x 2-5/16" x 2-3/8". The mix of stones sizes shall be approximately 28% full size, 57% two thirds size and 15% one third size.

2. Cementitous Materials: Materials shall conform to the ASTM, AASHTO and other referenced specifications as required by mix design specifications (MCIB or KCMMB).

3. Aggregates: Aggregates shall conform to the ASTM, AASHTO and other referenced specifications as required by mix design specifications (MCIB or KCMMB).

4. Other Constituents: Air–entraining agents, coloring pigments, integral water repellents, finely ground silica, etc. shall conform to ASTM standards where applicable, or shall be previously established as suitable for use in concrete.

5. Physical Requirements: The Contractor shall provide a certification showing compliance with the following requirements. The Engineer reserves the right to sample and test materials as deemed necessary.

a. Compressive Strength: At the time of delivery to the work site, the average compressive strength shall be not less than 8,000 psi with no individual unit strength less than 7,200 psi, with testing procedures in accordance with ASTM C 140.

b. Absorption: The average absorption shall not be greater than 5% with no individual unit absorption greater than 7%.

c. Durability: The manufacturer shall satisfy the Engineer either by proven field performance or the laboratory freeze–thaw test that the paving units have adequate durability.

   i. Proven Field Performance: Satisfactory field performance is indicated when units similar in composition, and made with the same manufacturing processes as those to be supplied to the Contractor, do not exhibit objectionable deterioration after at least three years. The units used as the basis for proven field performance shall have been exposed to the same environmental factors as is contemplated for the units supplied to the Contractor.

   ii. Freeze–Thaw Test: When tested in accordance with Section 8 of ASTM C 67, specimens shall have no breakage and not greater than 1.0% loss in dry weight of any individual unit when subjected to 50 freeze–thaw cycles. This test shall be conducted not more than 12 months prior to delivery of units.

d. Abrasion Resistance: When tested by sandblasting in accordance with ASTM C 418, specimens shall not have greater volume loss than 0.3 cubic inches per square inch. The average thickness loss shall not exceed 1/8-inch.

e. Permissible Variations in Dimensions: Length or width of units shall not differ by more than 1/16-inch from approved samples. Heights of units shall not differ by more than 1/8-inch from the specified standard.

f. Visual Inspection: All units shall be sound and free of defects that would interfere with the proper placing of unit or impair the strength or permanence of the construction. Minor cracks incidental to the usual methods of manufacturer, or minor chipping resulting from customary methods of handling in shipment and delivery, shall not be deemed grounds for rejection.

6. Sampling and Testing: The Engineer or his authorized representative shall be accorded proper facilities to inspect and sample the units at the place of manufacture from the lot ready for delivery. Sampling and testing of units shall be in accordance with ASTM C 140 except as required.

7. Rejection: In case the shipment fails to conform to the specified requirements, the manufacturer may sort it, and new test units shall be selected at random by the Engineer from the retained lot and tested at the expense of the manufacturer. In case the second set of test units fails to conform to specified requirements, the entire lot shall be rejected.

8. Expense of Tests: The expense of inspection and testing shall be borne by the Engineer except as specified otherwise above.

B. Base Course Concrete: Base course concrete shall conform to the requirements of MCIB Mix No. WA610–1–4 or an approved KCMMB 4K mix.

C. Sand for Laying Course: The sand for the laying course shall be well graded, clean, washed, sharp sand with 100% passing a 3/8" sieve size and a maximum of 3% passing a No. 200 sieve size. This is commonly known as manufactured concrete sand, limestone screening, or similar. Mason Sand will not be permitted.

2304.4 Construction

A. Product Handling: Paver stones shall be delivered and unloaded at jobsite on pallets and bound in such a

manner that no damage occurs to the product during handling, hauling and unloading.

B. Edge Restraint: All edges of the installed paver stone shall be restrained by the concrete curb, concrete sidewalk, or another suitable method for preventing the movement of the edge stones.

C. Concrete Base Course: A concrete base course shall be constructed in accordance with the requirements of Section 2301. The base course shall be shaped to the grade and cross section as shown on the plans with an allowable tolerance of 1/4-inch. The base course shall be 4-inches thick, and should be graded to allow a 1-inch thick sand course between the base and the paving stones, unless shown otherwise on the Plans.

Payment for concrete base course shall be subsidiary to other bid items. The finished base course must be approved by the Engineer before the placement of the sand laying course. The uncompacted sand laying course shall be spread evenly over the area to be paved and then screened to a level that will produce 1-inch thickness when the paver stones have been placed and vibrated. Once screened and leveled to the desired elevation, the sand laying course shall not be disturbed in any way.

D. Placing Paver Stones: The paver stones shall be installed in rows perpendicular to the major axis of the median being paved. Within each row the stone sizes shall be randomly mixed so that joints between stones are not normally aligned with joints between stones in adjacent rows. No joints shall be aligned for more than three consecutive rows. The paver stones shall be laid in such a manner that the desired pattern is maintained and the joints between the stones are as tight as possible. For maximum interlock it is recommended that joints between stones do not exceed 1/8 inch. String lines should be used to hold all pattern lines true.

The gaps at the edge of the paver surface shall be filled with standard edge stones or with stones cut to fit. Cutting shall be accomplished to leave a clean edge to the traffic surface using a double–headed breaker or a masonry saw. However, when cutting precision designed areas, a masonry saw is recommended. Whenever possible, no cuts should result with a paver less than 1/3 of original dimension.

Paver stones shall be vibrated to their final level in the sand laying course by two or three passes of a vibrating compactor capable of 3,000 to 5,000 pounds compaction force with the surface clean and joints open. After vibration, clean concrete sand containing at least 30% of 1/8-inch particles shall be spread over the paver stone surface, allowed to dry, and vibrated into the joints with additional passes of the plate vibrator so as to completely fill the joints.

Surplus material shall then be swept from the surface. Upon completion of work covered in this Section, the Contractor shall clean up all work areas by removing all debris, surplus material and equipment from the site.

After final vibrating, the surface shall be true to grade and shall not vary by more than 1/4-inch when tested with a 10 foot straight edge at any location on the surface.

2304.5 Method of Measurement

Concrete Paver Stones will be measured by the square foot or tenth part thereof.

2304.6 Basis of Payment

Concrete Paver Stones will be paid for by the Contract unit bid price.

SECTION 2305 MAINTENANCE OF TRAFFIC

2305.1 Scope

This section governs the furnishing of all labor, equipment and tools and for the performance of all work necessary to provide Maintenance of Traffic as specified herein, as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2305.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

ATSSA
Quality Standards for Work Zone Traffic Control Devices

Manual of Uniform Traffic Control Devices, Part VI (MUTCD)

2305.3 General

The Contractor is required to maintain access for pedestrians and vehicles to all properties served by the streets and sidewalks impacted by the construction.

2305.4 Traffic Maintenance and Warning Devices

A. The Contractor will be responsible for arranging for installation of the necessary traffic control devices (with the exception of the barricades and other channelizing devices) a minimum of 48 hours prior to beginning the project so that inspection can be conducted by the Engineer.

Traffic maintenance devices including barricades, flashing lights, flaggers and other traffic control devices shall be in conformance with "Part VI of the Manual on Uniform Traffic Control Devices" latest edition.

B. Device Maintenance: The Contractor's representative will make daily inspections of the traffic control devices installed and maintain records of any maintenance required and the date on which it was completed. These records will be maintained for the duration of the project and be incorporated as part of the final records. It shall be the Contractor's responsibility to maintain all traffic control devices in proper working condition and placement at all times. The Contractor shall promptly correct any deficiencies in traffic control.

C. Traffic Control Plan Revisions: Engineer reserves the right to make adjustments or revisions in traffic handling requirements that may become necessary after construction has started. These changes will be determined on the basis of periodic inspections throughout the duration of the project. Notice of such change will be transmitted to the Contractor and it will be his responsibility to make the necessary changes as soon as practicable after receipt of the notification.

2305.5 Pedestrian Traffic Control

A. Devices: All traffic control along pedestrian routes (sidewalks) shall meet the requirements of sections of the latest version of the MUTCD. Particular attention should be paid to 6D.01and 6D.02 for pedestrian safety.

B. Pedestrian Route Closures: Pedestrian routes shall not be closed unless approved by the Engineer. If a pedestrian route must be temporarily closed, an alternate accessible route must be maintained.

C. Pedestrian Access: Accessible pedestrian access to all buildings served by the sidewalk must be maintained at all times during the project.

D. Pedestrian Routes Protection: Existing pedestrian routes and alternate accessible routes shall be protected from construction activities at all times. This protection may include, but is not limited to, railings, fences, barricades, and covered walkways.

2305.6 Flashers and Other Traffic Control Devices

All traffic control devices shall be maintained in acceptable condition as defined by the latest ATSSA "Quality Standards for Work Zone Traffic Control Devices." Devices in unacceptable or marginal condition as determined above shall be removed from the job site and replaced with devices in acceptable condition.

2305.7 Method of Measurement

Maintenance of Traffic will be measured as specified by the Contract Documents. Measurements shall be per each device per day listed as identified in the Plans and as adjusted by the Engineer during construction. The device must be set for at least one–half of a calendar day for it to be measured for payment. Relocation of devices required by project phasing shown on the Plans or proposed by the Contractor shall be subsidiary to the line item.

2305.8 Basis of Payment

Maintenance of Traffic will be paid for by one of the following:

A. Contract unit bid price.

B. Contract lump sum bid price.

SECTION 2306 PAVEMENT MARKINGS

2306.1 Scope

This section governs the furnishing of labor, equipment, and materials and for the performance of work necessary to furnish and install white and yellow permanent or temporary retro–reflectorized pavement marking materials as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2306.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used.

ASTM

C 321	Standard Test Method for Bond Strength of Chemical–Resistant Mortars
C 501	Standard Test Method for Relative Resistance to Wear of Unglazed Ceramic Tile by the Tile Abraser
D 36	Standard Test Method for Softening Point of Bitumen (Ring and Ball Apparatus)
D 92	Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
D 93	Standard Test Methods for Flash Point by Pensky Martens Closed Tester
D 256	Standard Test Method Methods for Determining the Izod Pendulum Impact Resistance of Plastic
D 476	Standard Specification for Titanium Dioxide Pigments, Type II Rutile

D 562 Standard Test Method for Consistency of Paints Using Stormer Viscosimeter
D 570 Standard Test Method for Water Absorption of Plastics
D 638 Standard Test Method for Tensile Properties of Plastics
D 711 Standard Test Method for No–Pick–Up Time of Traffic Paint
D 768 Standard Specification for Yellow Iron Oxide
D 868 Standard Test Method for Evaluating Degree of Bleeding of Traffic Paint
D 1152 Standard Specification for Methanol (Methyl Alcohol)
D 1155 Standard Test Method for Roundness of Glass Spheres
D 1199 Standard Specification for Calcium Carbonate Pigments
D 1210 Standard Test Method for Fineness of Dispersion of Pigment–Vehicle Systems by Hegman–Type Gage
D 1214 Standard Test Method for Sieve Analysis of Glass Spheres
D 1475 Standard test Method for Density of Paint, Varnish, Lacquer, and Related Products
D 2240 Standard Test Method for Rubber Property–Durometer Hardness
D 2243 Standard Test Method for Freeze–Thaw Resistance of Waterborne Coatings
D 2369 Standard Test Method for Volatile Content of Coatings
D 2805 Standard Test Method for Hiding Power of Paints by Reflectometry
D 3723 Standard Test Method for Pigment Content of Water Emulsion by Low Temperature Ashing
D 3960 Standard Practice for Determining Volatile Organic Content (VOC) of Paints and Related Coatings
D 4060 Standard Test Method for Abrasion Resistance of Organic Coatings by Taber Abraser
D 4061 Standard Test Method for Retroreflectance of Horizontal Coating
D 4366 Standard Test Methods for Hardness of Organic Coatings by Pendulum Damping Tests
D 4796 Standard Test Method for Bond Strength of Thermoplastic Traffic Marking Material
D 5420 Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Striker Impacted by a Falling Weight (Gardner Impact)
E 70 Standard Test Method for pH of Aqueous Solutions With the Glass Electrode
E 303 Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester
E 308 Standard Practice for Computing the Colors of Objects by Using the CIE System
E 660 Standard Practice for Accelerated Polishing of Aggegrates or Pavement Surfaces Using a Small–Wheel, Circular Track Polishing Machine
E 1347 Standard Test Method for Color and Color–Difference Measurement by Tristimulus (Filter) Colorimetry
E 1349 Standard Test Method for Reflectance Factor and Color by Spectophotometry Using Bidirectional Geometry

AASHTO
M 247 Standard Specification for Glass Beads Used in Pavement Markings
M 249 Standard Specification for White and Yellow Reflective Thermoplastic Striping Material (Solid Form)
T 250 Standard Method of Test for Thermoplastic Traffic Line Material

Manual of Uniform Traffic Control Devices, latest Edition (MUTCD)

ACI
Federal Test Method Standard No. 141d, Method 4252 – Paint, Varnish, Lacquer and Related Materials; Methods of Inspection, Sampling and Testing
Federal Test Method Standard No. 141d, Method 6242 – Paint, Varnish, Lacquer and Related Materials; Methods of Inspection, Sampling and Testing
Federal Standard 595, Colors used in Government Procurement

Federal Specification TT–P–115a – Paint, Traffic (Highway, White and Yellow)
Federal Specification TT–P–1952B – Paint, Traffic and Airfield Marking, Water Emulsion Base

“Standard Color Chips for Highway Signs” (US Bureau of Public Roads, Washington D.C.)

KDOT Standard Specifications Section 2214.2.a(2)(d) Bond Strength

National Board of Fire Underwriters of the National Fire Protection Association Standards

2306.3 General

The permanent pavement markings shall be installed immediately after the roadway surface is complete unless prior approval is received by the Engineer. The installation of the yellow markings (as required) is the first priority. If the permanent markings cannot be installed and thus the roadway would be unmarked overnight, temporary removable markings shall be installed and remain until the permanent markings can be installed. The contractor shall make every possible effort to remove the temporary pavement markings and install permanent pavement markings within 48 hours. Only under extreme circumstances and with the approval of the Engineer, will the duration of the temporary pavement markings be extended. Under no circumstance should the temporary pavement markings be in place for more than 2 weeks. If permanent markings cannot be installed within the specified time then semi–permanent markings shall be installed following the guidelines as set forth in the latest edition of the Manual on Uniform Traffic Control Devices (MUTCD) Part VI, Sections F6 and G6. The temporary removable markings shall be removed prior to installation of the permanent markings. In situations where markings conflict with the traffic routing, such as a lane closure or a lane diversion, conflicting markings shall be removed prior to application of the next set of markings.

2306.4 Striping Applicability Chart

These charts provide guidance for the selection of striping materials:

Marking Material	Roadway Surface	Application	Durability
Thermoplastic	New asphalt	Permanent	High
Aggressive bond thermoplastic	Aged asphalt	Permanent	High
Preformed thermoplastic	Asphalt, concrete	Permanent	High
Cold plastic	Asphalt, concrete	Permanent	Moderate
Paint	All surfaces	Permanent, temporary	Low
Epoxy	All surfaces	Permanent	High
Temporary Tape (Type I)	All surfaces	Temporary	Low
Temporary Tape (Type II)	All surfaces	Temporary	Low
Line masking tape	All surfaces	Temporary	Low

Roadway Surface	Permanent Marking	Temporary Marking
New asphalt	Thermoplastic	Temporary Tape (I or II)
Old asphalt	Aggressive bond thermoplastic	Temporary Tape (I or II)
Slurry or microsurface	Thermoplastic	Temporary Tape (I or II)
Milled concrete or asphalt	Not applicable	Paint
Asphalt to be milled	Not applicable	Paint
Base asphalt	Not applicable	Paint, Temporary Tape (Type II)
New or old concrete	Aggressive bond thermoplastic, Epoxy	Paint
Concrete	Inlaid cold plastic	Paint
Diamond ground concrete	Epoxy	Paint

Note: Old asphalt is asphalt which is more than 6 months old, or which has been open to traffic.

2306.5 Symbol Applicability Charts

These charts provide guidance for the selection of text and non–text symbol materials:

Roadway Surface	Text Symbols	Temporary Text Symbols
New asphalt	Pre-formed thermoplastic	Temporary Tape (I or II)
Old asphalt	Pre-formed thermoplastic	Temporary Tape (I or II), paint
Slurry or microsurface	Pre-formed thermoplastic	Temporary Tape (I or II), paint
Milled concrete or asphalt	Not applicable	Paint
Asphalt to be milled	Not applicable	Paint
Base asphalt	Not applicable	Paint
New or old concrete	Inlaid cold plastic	Temporary Tape (I or II)
Concrete	Inlaid cold plastic	Temporary Tape (I or II)
Diamond ground concrete	Inlaid cold plastic	Temporary Tape (I or II)

2306.6 Prequalification

A. If the Owner has an established prequalification program, manufacturers interested in prequalifying material under this specification shall submit to the Owner:

1. A sample of the material. Sample quantities are determined by the Owner. The submittal of a material sample may be waived by the Owner at their discretion.

2. Certifications by qualified testing laboratories that the material meets all required tests.

3. A list of existing installations.

B. The Owner may test submitted samples or materials as used for compliance with all requirements of this specification.

C. Products will remain on the prequalified list as long as the results of verification testing and/or field performance are satisfactory. Any changes in formulation should be reported to the Owner for review and evaluation to determine if requalification is necessary.

D. No material shall be used unless the material has been prequalified or approved by the Engineer.

E. A list of qualified materials by manufacturer may be maintained by the Owner.

2306.7 Materials

A. Pre–Mix Glass Spheres: Pre–mix glass spheres shall be uncoated and conform to AASHTO M 247 Type 1. The glass spheres used in the formulation shall be lustrous, free from film, scratches, and pits. The glass spheres shall also meet the following requirements:

1. Roundness: The roundness of the spheres shall be a minimum of 70% when tested in accordance with ASTM D 1155.

2. Gradation: The gradation when tested in accordance with the method provided in ASTM D 1214 (by use of U.S. Standard Sieves) shall be:

Size of Sieve	Mass % Passing
No. 18	80 – 100
No. 50	20 – 50
No. 80	0 – 10

3. Refractive Index: When tested by a liquid immersion method at 77° F, the refractive index of the spheres shall be a minimum of 1.50.

B. Drop–On Glass Spheres: The spheres shall be manufactured from glass of a composition designed to be highly resistant to traffic wear and to the effects of weathering. The particles shall be spherical in shape, containing not more than thirty percent (30%) of irregularly shaped particles. They shall be essentially free of sharp angular particles, and particles showing milkiness or surface scoring or scratching. They shall meet the requirements of AASHTO M 247 Type 1.

1. Gradation: The gradation when tested in accordance with the method provided in ASTM D 1214 (by use of U.S. Standard Sieves) shall be:

Size of Sieve	% Passing (by Weight)
No. 20	100
No. 30	80 – 100
No. 50	18 – 35
No. 80	0 – 10
No. 100	0 – 2

2. Refractive Index: When tested by a liquid immersion method at 77° F, the refractive index of the spheres shall be within the range of 1.50 to 1.60.

3. Moisture Proof Requirements: The spheres shall show no tendency to absorb moisture in storage and shall remain free of clusters and hard lumps. The spheres shall flow freely from dispensing equipment at any time when surface and atmospheric conditions are satisfactory for application.

C. Thermoplastic Pavement Markings: This specification covers a white and yellow thermoplastic reflectorized pavement marking material of a type that is applied to asphalt road surfaces in a molten state by mechanical means to receive a surface application of glass spheres, and which upon cooling to normal pavement temperature, produces an adherent reflectorized stripe of specified thickness and width and is capable of resisting deformation.

1. Characteristics: The material shall not exude fumes that are toxic, obnoxious or injurious to person or property, when it is heated to the temperature range specified by the manufacturer for application. It shall remain stable when held for 4 hours at this temperature, or when subject to three reheatings after cooling to ambient temperature.

   The temperature–viscosity characteristics of the plastic material shall remain constant throughout repeated reheatings, and shall show like characteristics from batch to batch. There shall be no obvious change in color of the material either as a result of repeated reheatings or from batch to batch.

   The thermoplastic material shall easily extrude from the equipment to produce a cross–section of line 90 to 125 mil thick, which shall be continuous and uniform in shape, and have clear and sharp dimensions.

2. Serviceability: The compound shall resist deterioration by contact with sodium chloride, calcium chloride or other chemicals used to prevent roadway ice, or because of the oil content of pavement materials or from oil droppings or other effects of traffic. The markings shall remain intact under normal traffic conditions at temperatures below 140° F.

3. Specific Gravity: The material's specific gravity shall not be less than 1.8 nor exceed 2.3 referred to water at 77° F when determined by a water displacement method at 77° F.

4. Set Time: When applied at the specified temperature and thickness, the material shall set to bear traffic in not more than 2 minutes when the air temperature is 50° F and not more than 10 minutes when the air temperature is 90° F.

5. Composition: The thermoplastic pavement marking material shall be homogeneously composed of pigment, filler, resin binder and glass reflectorizing spheres. The solid resin shall be a "maleic–modified glycerol ester resin" (alkyd binder) comprising at least one–third of the binder compositions and be no less than eight percent (8%) by weight of the entire material formulation. The alkyd binder shall consist of a mixture of synthetic resins (at least one of which is solid at room temperature), and high boiling point plasticizers. The material shall not contain any petroleum derived ingredients. Yellow pigment shall be heat stabilized encapsulated lead chromate. The thermoplastic pavement marking material shall contain the following ingredients:

INGREDIENT (Percent by Weight)	WHITE	YELLOW
Binder	18.0 min.	18.0 min.
Titanium Dioxide	10.0 min.	-----
Glass Spheres	20.0 – 50.0	20.0 – 50.0
Lead Chromate	-----	2.0 – 4.5
Inert Fillers	42.0 max.	50.0 max.

The material shall be thoroughly mixed and furnished in a free flowing granular form. The material shall meet the requirements of this specification for a period of one year. The material shall readily melt in a uniform mixture. The material shall be free from all skins, dirt, and foreign objects. It shall be of such composition that it will not bleed, stain or discolor when applied to bituminous pavement. The manufacturer shall replace material not meeting the above requirements.

6. Color: The color of the thermoplastic material after heating for 4 hours ± 5 minutes at 425 ± 3° F shall conform to the following when tested by Federal Test Method Standard 141 Method 4252:

White	Federal Color Chip No. 17875 (Fed. Std. No. 595)
Yellow	Federal Color Chip No. 13538 (Fed. Std. No. 595)

7. Reflectance: The daylight luminous reflectance of the white material shall be not less than 75% when tested according to ASTM E 1347. The yellow shall have a minimum brightness of 45% relative to magnesium oxide, and shall be within the green and red tolerance of the "Standard Color Chips for Highway Signs (January 1939)" obtainable from the United States Bureau of Public Roads, Washington, D.C. (TT–P–115a).

8. Softening Point: After heating the thermoplastic material for 4 hours + 5 minutes at 425 ± 3° F and testing in accordance with ASTM D 36, the material shall have a softening point 215 ± 15° F.

9. Flowability: After heating the thermoplastic material for 4 hours ± 5 minutes at 425 ± 3° F and testing for flowability, the white thermoplastic shall have a maximum percent residue of 18% and the yellow thermoplastic shall have a maximum residue of 21%.

   After heating the thermoplastic material for 8.5 hours ± 5 minutes at 425 ± 3° F and testing for flowability, the thermoplastic shall have a maximum percent residue of 28%.

10. Indentation Resistance: Hardness shall be measured by a Shore Durometer, Type A2, as described in ASTM D 2240, except that the Durometer and the panel shall be at 77° F, and a 4.4 lb load applied. After 15 seconds, the reading shall be not less than 55.

11. Abrasion Resistance: The material shall not show a maximum loss of 0.02 ounces subjected to 200 revolutions on a Taber Abraser at 77° F, using H–22 calibrate wheels, weighted to 17.6 ounces. The wearing surface should be kept wet with distilled water throughout the test. The panel for this test shall be prepared by forming a representative lot of material at a thickness of 125 mil on a 4-inch square panel (thickness 0.050 + 0.001 inch) on which a suitable primer has been previously applied.

12. Low Temperature Impact Resistance: The materials shall not fracture when subjected to an impact of 64 inch pounds at –4° F, for at least 3 hours. The panel is then placed in an instrument also maintained at –4° F, consisting of a 10.5 pound freely falling weight controlled to drop vertically for 6-inches onto the surface of the panel, which it strikes with a hemispherical indentor having a radius of 0.28-inches.

13. Water Absorption: Materials shall have a maximum of 0.5 percent by weight of retained water when tested by ASTM D 570, procedure (A).

14. Yellowness Index: The white thermoplastic material shall not exceed a yellowness index of 0.15.

15. Flash Point: The thermoplastic material shall have a flash point not less than 475° F when tested in accordance with ASTM D 92.

16. Cracking Resistance: After heating the thermoplastic material for 4 hours + 5 minutes at 425 ± 3° F; applying to concrete blocks, and cooling 15 ± 3° F, the material shall show no cracks. Properly applied, the material shall show less than six stress cracks per ten lineal feet of markings independent of pavement fracturing and faulting, for at least six months.

D. Aggressive Bond Thermoplastic Pavement Markings: This specification covers a white and yellow adhesive thermoplastic reflectorized pavement marking material that is applied to road surfaces, including Portland Cement Concrete (PCC) and aged asphalt without need of a primer/sealer. The material is applied to the road surface in a molten state by mechanical means with surface application of glass beads. Upon cooling to normal pavement temperature, it produces an adherent reflectorized stripe of specified thickness and width with limited thermal/seasonal deformation. In order to qualify as a non–sealer thermoplastic that can be applied to concrete surfaces without a sealer, the material must meet or exceed the requirements listed below.

1. Characteristics: The thermoplastic material shall be homogeneously composed of pigments, resins, polymers (adhesive constituent), glass reflectorizing spheres and other fillers. The thermoplastic material shall be available in a variety of surface delineation colors from the same manufacturer. The manufacturer shall have the option of formulating the material according to their own specifications.

   However, certain physical and chemical requirements specified must be satisfied in order to qualify as a non–primed striping application for PCC and aged asphalt surfaces.

The material shall not exude fumes which are toxic or injurious to persons or properties upon heating to application temperature.

2. Specific Gravity: The specific gravity of the white and yellow thermoplastic pavement marking material shall not exceed 2.15.

3. Composition: The pigment, intermix reflectorizing spheres, and fillers shall be uniformly dispersed in the resin and polymer upon heating to application temperature. The material shall be free of dirt and foreign matter and must meet or exceed the compositional requirements (percentage by weight) indicated below. The total resin/binder content must be 22% min. – 26% max. (weight) of total product ingredients.

Test Component	White	Yellow (Lead Chromate)	Yellow (Heavy Metal Free)
Glass Beads	30% min.	30% min.	30% min.
Pigment – Ti02	10% min.	N/A	N/A
Yellow (PbCr03)	N/A	2% min.	Federal Color
Resin/Binder Content	22% min.	22% min.	22% min.
Inert Fillers	42.0 max.	50.0 max.	At manufacturer's discretion

4. Color: The thermoplastic material after heating for four hours ± 5 min. at 425 ± 3° F and cooled to 77 ± 3° F shall meet the following:

White	Daylight reflectance at $45^0 – 0^0$ – 80% min.
Yellow	Daylight reflectance at $45^0 – 0^0$ – 45% min.

Yellow color shall match Federal Test Standard Number 5958 – Color 13538 and lie within the following ranges:

X	0.485 – 0.510
Y	0.445 – 0.470

The chromaticities and luminance factors of ordinary colors of retroreflecting material shall be determined under an angle of illumination of 45 degrees; direction of view perpendicular to surface; and illumination CIE standard illuminant D65.

5. Bond Strength: After heating the thermoplastic material for four hours ± 5 minutes at 425 ± 3° F, the bond strength to Portland Cement Concrete (PCC) shall equal or exceed 275 psi (ASTM Standard Test Method for Bond Strength of Thermoplastic Traffic Marking Materials – D 4796 or ASTM C 321). Failures of type described in Section 6.1 of ASTM D 4796 bond test, must be repeated to obtain a quantifiable number. Failure of types 6.2, 6.3, and 6.4 of ASTM D 4796 bond test, must exceed the specified thermoplastic – cement brick separation.

6. Low Temperatures Cracking (Stress) Resistance for Extended Period: The material shall be tested according to AASHTO T 250 Section 7 with Section 7.2.3, modified for an extended cold temperature of 15 ± 3° F exposure period of 72 hours. Any cracking shall constitute failure of the material to qualify as a non–sealer aggressive bonding material for PCC road surfaces.

7. Impact Resistance (Gardner Falling Weight): The test specimens should be formed according to the following procedure:

   Heat approximately 14.1 ounces of material in an open pint can for 4 hours at 425 ± 3˚ F. Preheat specimen draw down blade, 2-inches x 4-inches with a 1/8-inch die opening for approximately one hour at 425 ± 3˚ F. The blade is usually placed in the oven containing the sample material during the last hour of sample heating.

   After heating the sample for four hours, remove the sample and the draw down blade from the oven. Place the 125–mil blade onto a PCC block. Quickly pour the sample 425 ± 3^0 F into the opening of the draw down screed and draw down the sample for the entire length of the concrete block. Allow the drawn down test sample to condition in the open in the standard laboratory atmosphere, 73.4 ± 3^0 F and 50 ± 5% relative humidity.

   Perform the testing procedure according to ASTM D 5420 Section 11. Record and report the type of failure as (a) crack or cracks on the surface, (b) cracks that penetrate the entire thickness, (c) brittle shatter (the test specimen in several pieces after impact), or (d) ductile failure (the specimen is penetrated by a blunt tear).

   Both the yellow and white non–sealer materials shall have minimum impact resistance of 80 inch pounds with no visible surface cracks.

8. Impact Resistance (Notched Izod): After heating the material for four hours ± 5 minutes at 425 ± 3° F and forming test specimens according to AASHTO T 250 Section 8, both the yellow and white samples shall be a minimum notched impact resistance of 11.0 ± 0.3 inch pounds. The specimens shall be tested both at room temperature 73.4 ± 3° F and low temperature of 15 ± 3° F in accordance with ASTM D 256 test method A.

9. Oil and Grease Resistance: The thermoplastic material shall show no signs of deterioration or solubility after motor oil is rubbed vigorously into a sample for 2 minutes and allowed to penetrate for 5 minutes.

10. Set Time: When applied at a temperature range of 412.5 ± 12.5° F and thickness of 90 to 125 mil the material shall set to bear traffic in not more than 2-minutes when the air temperature is 50 ± 3° F and not more than ten minutes when the air temperature is 90 ± 3° F.

11. Flash Point: The thermoplastic material shall have a flash point of not less than 500° F when tested in accordance with ASTM D 92.

12. Storage Life: The material shall maintain the requirements of this specification for a minimum period of one year. The thermoplastic material must melt uniformly with no evidence of skins or unmelted particles for this one year time period. Any material failing to do so shall be replaced by the manufacturer at their expense.

13. Packaging and Marking: The thermoplastic material shall be packaged in suitable containers to which it will not adhere during shipment and storage. The container of thermoplastic material shall weigh approximately 50 lbs. Each container shall designate user information, manufacturer's name and address, batch number and date of manufacture. Each batch manufactured shall have its own separate number. The label shall carry appropriate user warnings and instructions.

14. NTPEP Test Program: The material must have been applied, without surface primer, on two NTPEP

Decks (PCC) and evaluated for a period of at least one year. A minimum of 90% of the original pavement striping must be intact on the PCC decks after a one–year review period. The percent retention is calculated based on the measured test area square footage (neglecting mil thickness wear down) minus the road surface areas that are exposed due to cracking and chipping away of thermoplastic from the concrete surface caused by product bond failure to the substrate.

E. Preformed Thermoplastic Pavement Markings: This specification is for the furnishing of retroreflective preformed thermoplastic pavement marking materials that can be adhered to asphalt, concrete and Portland cement concrete pavements by means of heat fusion. The applied markings shall be very durable, oil and grease impervious and provide immediate and continuing retroreflectivity.

1. Characteristics: The preformed marking material shall consist of a resilient white and yellow polymer thermoplastic with uniformly distributed glass beads throughout its entire cross section.

   Preformed words and symbols shall conform to the applicable shapes and sizes as prescribed in the latest revision of the Manual on Uniform Traffic Control Devices (MUTCD).

   The preformed markings shall be fusible to asphalt concrete and Portland cement concrete pavements by means of the normal heat of a propane type of torch. Adhesives, primers or sealers shall not be used prior to the preformed marking application on asphalt concrete and Portland cement concrete pavements.

   The preformed markings shall conform to pavement contours, breaks and faults through the action of traffic at normal pavement temperatures. The markings shall have resealing characteristics and be capable of fusing to itself and previously applied worn hydrocarbon and/or alkyd thermoplastic pavement markings.

   The preformed markings shall be capable of application on new, dense and open graded asphalt concrete wearing courses during the paving operation in accordance with the manufacturer's instructions. After application, the markings shall be immediately ready for traffic. The preformed markings shall be suitable for use for one year after the date of receipt when stored in accordance with the manufacturer's recommendations.

   The preformed thermoplastic markings shall not be brittle and must be sufficiently cohesive and flexible at temperatures exceeding 50 degrees F for one person to carry without the danger of fracturing the material prior to application.

2. Composition: The retroreflective pliant polymer thermoplastic pavement markings shall consist of a homogeneous mixture of high quality polymeric thermoplastic binders, pigments, fillers and glass beads. The thermoplastic material must conform to AASHTO designation M 249 with the exception of the relevant differences due to the material being supplied in a preformed state.

3. Glass Beads: The markings shall contain 30% glass spheres which shall conform to AASHTO M 247 Type 1, except that glass spheres shall have a minimum of 70% true spheres on each sieve and 80% true spheres overall.

   The glass beads must be homogeneously blended throughout the material with a securely bonded protruding exposed layer of beads that provide immediate and continuous retroreflectivity; no additional glass beads shall be dropped on the material during application. Curved arrows must be available without protruding glass beads if reversibility is needed.

4. Retroreflectivity: The preformed marking shall upon application exhibit uniform adequate nighttime retroreflectivity when tested in accordance with ASTM E 1710. At 86 degree 30 feet incidence angle and 1 degree 30-feet divergence angle, the markings shall have average minimum intensities of 350 millicandelas for white and 175 millicandelas for yellow as measured with a Mirolux or LTL-2000 retroreflectometer. Follow manufacturer's instructions for use.

   Using a Taber Abraser with an H–18 wheel and a 4.4 ounce load, the sample shall be inspected at 200 cycles, under a microscope, to observe the extent and type of bead failure. No more than 15% of the beads shall be lost due to popout and the predominant mode of failure shall be "wear down" of the beads.

5. Color Characteristics: The thermoplastic material without glass beads shall meet the following:

White	Daylight reflectance at 45^0 / 0^0 of 80% min.
Yellow	Daylight reflectance at 45^0 / 0^0 of 45% min.

   The daylight reflectance shall not change significantly when the preformed thermoplastic is properly applied to the roadway surface.

   For highway use, the white markings shall contain a minimum of 8% by weight of Titanium Dioxide pigment to ensure a color similar to Federal Highway White, Color No. 17886 Standard 595. Yellow color shall reasonably match color chip Number 13538 of Federal Standard 595 and be lead free.

6. Skid Resistance: The surface of the preformed thermoplastic markings shall provide a minimum skid resistance value of 45 BPN when tested according to ASTM E 303.

7. Thickness: The width of the supplied material shall have a minimum average thickness of 90 mils.

8. Flexibility: The preformed thermoplastic marking material shall have flexibility at 50° F such that no cracking occurs in the test sample when a 1-inch by 6-inches sample is bent through an arc of 900 at a uniform rate in 10 seconds (9 seconds per degree) over a one inch mandrel. The sample must be conditioned prior to testing at 50 ± 2° F for a minimum of four hours. At least two specimens tested must meet the flexibility requirements at 50° F for a passing result.

9. Environmental Resistance: The applied markings shall be resistant to deterioration due to exposure to sunlight, water, oil, diesel fuels, gasoline, pavement oil content, salt, and adverse weather conditions.

10. Effective Performance Life: When properly applied, in accordance with the manufacturer's instructions, the pavement markings shall be neat and durable. The markings shall remain retroreflective and show no fading, lifting, shrinkage, tearing, roll back or other signs of poor adhesion.

F. Cold Plastic Pavement Markings: This specification covers a white and yellow pre–formed cold plastic reflectorized pavement marking material of a type that is applied to a road surface by an inlaid, pre–coated pressure sensitive adhesive that produces an adherent reflectorized stripe of specified thickness and width and is capable of resisting deformation.

1. Characteristics: The material shall be manufactured without the use of lead–chromate pigments or other, similar, lead–containing chemicals.

   Glass beads shall be incorporated to provide immediate and continuing retroreflection. Ceramic skid particles shall be bonded to the top layer to provide a skid–resistant surface.

Preformed word and symbol markings shall conform to the applicable shapes and sizes as outlined in the Manual on Uniform Traffic Control Devices (MUTCD).

The preformed markings shall be capable of being adhered to pavements by an inlaid, pre–coated pressure sensitive adhesive. A surface preparation adhesive may be used to precondition the inlay pavement surface.

The preformed marking film shall mold itself to pavement contours by the action of traffic. Following proper inlay application and tamping, the markings shall be immediately ready for traffic.

2. Composition: The retroreflective pavement marking film shall consist of a mixture of high–quality polymeric materials, pigments and glass beads distributed throughout its base cross–sectional area. A reflective layer of glass beads and a layer of skid–resistant ceramic particles shall be bonded to the top urethane wearing surface. The urethane wear surface shall have a nominal thickness of 5 mil (0.005 inches). The film shall have a pre–coated, shear–resistant, pressure sensitive adhesive.

3. Color: The daytime color of the white film shall provide a minimum initial luminance factor, Y, of 80 and shall conform to the following chromaticity requirements:

WHITE		YELLOW	
X Values	**Y Values**	**X Values**	**Y Values**
0.290	0.315	0.474	0.455
0.310	0.295	0.491	0.435
0.330	0.360	0.512	0.486
0.350	0.340	0.536	0.463

The daytime color of the yellow film shall provide an initial luminance factor, Y, in a range of 36 to 59 and shall conform to the above chromaticity requirements:

Measurements shall be made in accordance with ASTM E 1349, using illuminant “C” and 0/45 (45/0) geometry. Calculations shall be in accordance with ASTM E 308 for the 2–degree observer.

4. Reflectance: The white and yellow films shall have the following initial minimum reflectance values as measured in accordance with the testing procedures of ASTM D 4061. The photometric quantity to be measured shall be coefficient of retroreflected luminance (RL) and shall be expressed as millicandelas per square foot per foot–candle (mcd-ft–2-fc–1).

	WHITE			YELLOW		
Entrance Angle	86.0^0	86.0^0	86.5^0	86.0^0	86.0^0	86.5^0
Observation Angle	0.2^0	0.5^0	1.0^0	0.2^0	0.5^0	1.0^0
Retroreflected Luminance R_L (mcd–ft^{-2}–fc^{-1})	700	500	400	410	250	175

5. Skid Resistance: The surface of the retroreflective films shall provide an initial minimum skid resistance value of 55 BPN as measured by the British Portable Skid Tester in accordance with ASTM E 303.

The surface of the retroreflective film shall retain an average skid resistance value of 45 BPN, when tested in accordance with ASTM E 303, for a period of one year when installed in non–snow removal areas. The 45 BPN minimum value shall be an average of several readings taken in both the wheel

track and non–wheel track areas.

6. Tensile Strength and Elongation: The film shall have a minimum tensile strength of 150 lbs. per square inch of cross–section when measured in the direction of the length of the roll and tested in accordance to ASTM D 638, except that a sample 6 inch x 1 inch shall be tested at a temperature between 70° F and 80° F using a jaw speed of 10 to 12 inches per minute. The sample shall have a maximum elongation of 50% at break when tested by this method.

7. Reflectivity Retention: The glass beads must be strongly bonded and not be easily removed by traffic wear. Using a Taber Abraser with an H–18 wheel and a 4.4 ounce load, the sample shall be inspected at 200 cycles, under a microscope, to observe the extent and type of bead failure. No more that 15% of the beads shall be lost due to popout and the predominant mode of failure shall be “wear down” of the beads.

8. Glass Beads: The size, quality and refractive index of the glass beads shall be such that the performance requirements for the markings shall be met. The bead adhesion shall be such that beads are not easily removed when the material surface is scratched. The film shall have glass bead retention qualities such that when a 2-inches by 6-inches sample is bent over a 1/2-inch diameter mandrel, with the 2-inch dimension perpendicular to the mandrel axis, microscopic examination of the area on the mandrel shall show no more than 10% of the beads with entrapment by the binder of less than 40%.

9. Thickness: The film, without adhesive, shall have a minimum thickness of 60 mil.

G. Lead–Free, Water–Borne Emulsion Based White and Yellow Traffic Paint: The pavement marking paint shall be rapid dry. The traffic paint shall provide optimum adhesion for glass spheres when both binder and glass spheres are applied in the recommended quantities.

1. Drying Time: When applied at a wet film thickness of 15 mils with a top dressing of 6–10 pounds of glass spheres per gallon of paint and when the pavement temperature is between 50° F and 120° F and the relative humidity doesn't exceed 80%, the binder shall dry to a no–tracking condition in a minimum of 20 seconds and a maximum of 60 seconds.

   These dry times shall not be exceeded when the paint is applied with specialized equipment so as to have the pigmented binder at a temperature of 150^0 F to 170^0 F at the spray gun.

   The no–tracking condition shall be determined by passing over the applied line in a simulated passing maneuver with a passenger car traveling 35 MPH. There shall be no visual deposition of the paint to the pavement surface when viewed from a distance of 50 feet. Furthermore, the pigmented binder, without glass spheres, shall dry to no–tracking condition in 180 seconds or less when tested in accordance with ASTM D 711.

2. Directional Reflectance: The daylight directional reflectance of white pigmented binder (without glass spheres) shall be not less than 85% relative to magnesium oxide when tested in accordance with Federal Test Method Standard No. 141d, Method 6242. If yellow, after drying shall suitably match color 13538 of Federal Standard 595.

3. The paint for the pavement markings shall contain no lead and/or chromium and shall have volatile organic content conforming to the latest Environmental Protection Agency regulations.

4. In addition, the paint and/or components shall conform to the American Society for Testing Materials

(ASTM) as follows:

D 93	Standard Test Methods for Flash Point by Pensky Martens Closed Tester
D 476	Standard Specification for Titanium Dioxide Pigments, Type II Rutile
D 562	Standard Test Method for Consistency of Paints Using Stormer Viscosimeter
D 711	Standard Test Method for No–Pick–Up Time of Traffic Paint
D 768	Standard Specification for Yellow Iron Oxide
D 868	Standard Test Method for Evaluating Degree of Bleeding of Traffic Paint
D 1152	Standard Specification for Methanol (Methyl Alcohol)
D 1199	Standard Specification for Calcium Carbonate Pigments
D 1210	Standard Test Method for Fineness of Dispersion of Pigment–Vehicle Systems by Hegman–Type Gage
D 1475	Standard test Method for Density of Paint, Varnish, Lacquer, and Related Products
D 2243	Standard Test Method for Freeze–Thaw Resistance of Waterborne Coatings
D 2369	Standard Test Method for Volatile Content of Coatings
D 2805	Standard Test Method for Hiding Power of Paints by Reflectometry
D 3723	Standard Test Method for Pigment Content of Water Emulsion by Low Temperature Ashing
D 3960	Standard Practice for Determining Volatile Organic Content (VOC) of Paints and Related Coatings
D 4060	Standard Test Method for Abrasion Resistance of Organic Coatings by Taber Abraser
D 4366	Standard Test Methods for Hardness of Organic Coatings by Pendulum Damping Tests
E 70	Standard Test Method for pH of Aqueous Solutions With the Glass Electrode
E 1347	Standard Test Method for Color and Color–Difference Measurement by Tristimulus (Filter) Colorimetry

The paint shall show no cracking, flaking, blistering, appreciable loss of adhesion, softening, coagulation, discoloration, and have a minimum bleeding ratio of 0.97 when tested in accordance with Federal Specification TT–P–1952B.

The paint shall be capable of dilution with water at all levels without curdling or precipitation such that the wet paint can be readily cleaned up with water only.

The minimum contrast ratio shall be 0.96 when drawing down with a 0.005 bird film applicator on a 2A Leneta Chart or equal and air–dried for 24 hours.

Contrast Ratio = Black/White.

H. Temporary Tape: This specification covers pavement marking tape of two colors, white and yellow, and of two types, Type I and Type II.

Type I Regular (This type is not required to be easily removable intact)

Type II Removable (This type is to be readily removable intact, either manually or with a roll–up device after having been in place through the construction season)

1. General: This material shall be a pavement striping tape designed to provide reflective delineation under both dry and moderate rainfall conditions. The tape shall consist of glass spheres tightly embedded to a binder; on a conformable backing pre-coated with a pressure sensitive adhesive. The striping material shall be thin, flexible, formable, and following application shall remain conformed to the texture of the pavement surface. The tape shall be furnished in the color and type designated on the Plans or in the Contract Documents. The markings shall be pre-coated with a pressure sensitive

adhesive and shall be capable of being adhered to asphalt concrete or Portland cement concrete in accordance with manufacturer's instructions without the use of heat, solvents or other additional adhesive means, and shall be immediately ready for traffic after application. The adhesive shall not require a liner or release paper. The striping material shall have a uniform appearance, free from cracks and the edges shall be true, straight and unbroken. The material shall be weather resistant and show no appreciable fading, lifting or shrinkage when applied in accordance with the manufacturer's recommendations.

2. Color and Daylight Reflectance: The daylight reflectance (ASTM E 1347) of white shall be not less than 70%. The color of yellow shall be within the red and green tolerance limits of the Highway Yellow Color Tolerance Chart issued by the U.S. Department of Transportation.

3. Dimensions: The width and length shall be as shown on the Plans or in the Contract Documents. The material shall be available in rolls and there shall be no more than three splices per 50 yards of length.

4. Packaging: The material shall be packaged in accordance with accepted commercial standards and when stored under normal conditions, shall be suitable for use for a period of at least one year after purchase.

5. Adhesion: The material shall adhere to asphalt and concrete surfaces when applied according to manufacturer's recommendations at surface temperatures above 50° F and shall be immediately ready for traffic following application.

6. Removability: Type II tape shall be removable from asphalt and Portland cement concrete intact or in large pieces, either manually or with a roll–up device, at temperatures above 40° F without use of heat, solvents, grinding or blasting.

7. Reflection: The white and yellow material shall be retroreflective, reflecting white or yellow respectively and shall be readily visible at night when viewed with automobile headlamps using high beams from a distance of at least 300 feet.

8. Durability: Type II material shall maintain adhesion, show no alligatoring, show no signs of pulling apart, and shall suffer no more than a 25% loss of beads, sand and grit when subjected to 30,000 revolutions on a small–wheel circular track as described in ASTM E 660, with the following variations or exceptions:

    a. Two opposite wheels mounted with Goodyear 3.40–5 NHS Industrial Rib tires shall be used with a total load of 51.5 pounds on each tire. Tire air pressure shall be maintained at 25 pounds. The wheels shall be mounted perpendicular to the specimens and toed out 20 to produce a slight abrading action.
    b. Specimens shall be applied to 6-inch diameter dense graded bituminous concrete surface which has been compacted at 3,000 psi for two minutes. After application, the specimens shall be allowed to cure at least 16 hours before beginning the test.

I. Epoxy: This specification is for the application of epoxy resin and glass beads as reflective pavement markings on Portland cement concrete or bituminous pavements. The epoxy resin material shall be toxic heavy metal free, two–component, 100% solids, and shall be formulated and tested to perform as a pavement marking material with glass spheres applied to the surface. The two components are an epoxy resin and an amine curing agent. The Contractor shall provide complete manufacturer’s specifications and material safety data sheets to the Engineer for all material furnished.

1. Characteristics: The material shall not exude toxic fumes when heated to application temperature. The material which, when mixed in the proper ratio and applied at 0.14 mil wet film thickness at 74.8° F with the proper saturation of glass beads, has a no–tracking time of less than 40 minutes for slow curing material and less than 10 minutes for rapid curing material. The material shall be capable of fully curing under a constant surface temperature of 32° F or above.

2. Properties of Cured Material

   a. Color: Provide white which complies with Federal Standard 595 17875. Provide yellow which matches the standard shade within the red and green tolerance limits when compared with the Highway Yellow Color Tolerance chart available from the U.S. Department of Transportation, Washington, D.C. (Federal Standard 595, 13538).
   b. Abrasion Resistance: 0.0028 ounces maximum loss when tested at 30 ± 1.5 mils and a 72 hour cure and with a CS–17 wheel under a load of 2.2 lbs. for 1000 cycles.
   c. Hardness: Shore D hardness of 75 minimum.
   d. Adhesion to Concrete: When catalyzed, has such a high degree of adhesion to the specified concrete surface that there is a 100% concrete failure. Apply the material at a film thickness of 15 ± 1.5 mils to concrete with a minimum compressive strength of 4,061 psi. Allow the material to cure for 72 hours at 77° F before the test is performed.
   e. Yellowness Index: White only. Value after 72 hours in QUV – 30 maximum when tested at 15 ± 1.0 mils and a 72 hour cure.
   f. Field Evaluation: Field test materials at AASHTO NTPEP regional test facilities, which include both hot and cold weather conditions and are a minimum of six months in duration.

3. Glass Beads For Drop–On Application (double drop system)

   a. For the first drop, furnish large beads, which are compatible with the epoxy system, and comply with AASHTO M 247 except with the following gradation (FP–96, Type 4):

Sieve Size	Percent Passing
No. 10	100
No. 12	95 – 100
No. 14	80 – 95
No. 16	10 – 40
No. 18	0 – 5
No. 20	0 – 2

   b. For the second drop, furnish regular beads which are specifically manufactured to be compatible with the epoxy system, and which comply with the requirements of AASHTO M 247, Type 1.
   c. Both types of beads are to be coated with a moisture resistant coating and an adhesion promoting coating which is compatible with the epoxy system.

4. Test Methods

   a. Adhesion to Concrete - KDOT Standard Specifications Section 2214.2.a(2)(d) Bond Strength
   b. Hardness ASTM D 2240
   c. Abrasion Resistance ASTM C 501

2306.8 Method of Installation

The proposed permanent markings shall be laid out by the Contractor as shown on the Plans in advance of the marking installation. Markings shall not be applied until the layout and conditions of the surface have been approved by the Engineer. If a paint line is used for layout purposes (in lieu of a chalk line or string line) the paint line shall not be wider than 1/2-inch in width. If wider, the paint shall be removed following the application of the final permanent marking. New markings shall match existing markings as applicable in areas abutting existing road surfaces. The surface shall be dry and all dust, debris, oil, grease, dirt, temporary markings and other foreign matter shall be removed from the road surface prior to the application of the permanent marking material.

The Contractor shall be responsible for keeping traffic off freshly applied markings until they have set sufficiently to bear traffic. Traffic control is the responsibility of the Contractor and shall conform to the MUTCD. Failure to comply with traffic control guidelines will result in the pavement marking Contractor being directed to stop operations and leave the site until proper and approved traffic control has arrived and is put in place.

Temporary pavement markings shall be installed the same day that the existing pavement markings are damaged, removed or covered up prior to lane opening.

Temporary pavement markings shall be installed using the same cycle length as the permanent markings and be at least 2-feet long. Double yellow markings shall be used for temporary centerline and single white markings shall be used for temporary lane lines on four lane roadways. Single yellow markings shall be used for temporary centerline on two lane roadways as directed by the Engineer.

Half–cycle lengths with a minimum of 2-foot stripe and 10-foot gap should be used on roadways with severe curvature.

A. Glass Spheres: The drop on glass beads shall be applied at a rate of eight to ten pounds per 100 square feet.

B. Thermoplastic Pavement Markings: Thermoplastic material shall readily apply to the pavement at temperatures of 400° F to 425° F from approved equipment to produce an extruded line that shall be continuous and uniform in shape having clear and sharp dimensions. Application temperatures shall not exceed 450° F.

Thermoplastic may be used for cross walks and stop bars as specified under the conditions described herein. The thermoplastic markings shall be applied to the pavement surface in a molten state by mechanical means with surface application of glass spheres, and upon cooling to normal pavement temperature, produce an adherent retro–reflectorized stripe of specified thickness and width and capable of resisting deformation.

1. Equipment: The equipment used to install the thermoplastic shall be as follows:

    a. A self–propelled machine is required in order to fulfill the timing needs of the marking installation for longitudinal lines.
    b. If thermoplastic is used for transverse lines, i.e., crosswalks and stop lines, a push cart shall be used according to the following requirements:
        i. Only one pass with the thermoplastic pavement marking equipment shall be allowed in order to provide the required line width according to the Plans.
        ii. Multiple passes of narrower lines with overlaps to provide the required width shall not be allowed unless otherwise approved by the Engineer after review of a test strip installation.
        iii. If approved, the Contractor shall be required to heat the seam with a torch and feather the overlapped material with a putty knife. Liquid thermoplastic shall not be used for word or symbol markings.
    c. Constructed to provide mixing and agitation of the materials. Conveying parts between the main material reservoir and the shaping die shall be constructed as to prevent accumulation and clogging.

d. Constructed so that mixing and conveying parts up to and including the shaping die will maintain the materials at a temperature between 400° F and 450° F. To assure that the material does not fall below the minimum temperature, the shaping die shall be heated by means of a gas–fired infrared heater or a heated, oil–jacketed system.

e. Constructed as to insure continuous uniformity in the dimensions of the stripe. The applicator shall provide a means for cleanly cutting off square stripe ends and shall provide a method of applying “skip” lines. The equipment shall be constructed to be able to provide for varying die widths and to produce varying widths of traffic markings. The use of pans, aprons, or similar appliances with die overruns will not be permitted.

f. All conditions apply as stated above for material temperatures, line definition and workmanship when a hand pushcart is used for cross walks. The Engineer will verify measurement.

g. Equipment with a special kettle for melting and heating the material shall be provided. The kettle shall be equipped with a thermostat so that heating can be done by controlled heat transfer liquid rather than by direct flame so as to provide positive temperature control and prevent overheating of the material.

h. Constructed for a nominal application of 90 – 125 mil thickness.

i. The heater and applicator shall be so equipped and arranged as to meet the requirements of the National Board of Fire Underwriters of the National Fire Protection Association, of the state, and of the local authorities.

j. Equipped with an automatic glass bead dispenser attached to the striping machine in such a manner that the beads are dispensed almost instantaneously upon the installed line. The glass bead dispenser shall be equipped with an automatic cut–off control synchronized with the cut–off of the thermoplastic material.

k. The equipment shall be arranged as to permit preheating of the pavement immediately prior to application of the thermoplastic material, if preheating is recommended by the thermoplastic manufacturer.

l. The applicator shall be capable of containing a minimum of 1000 pounds of molten material (not applicable for hand–liner use).

m. The applicator shall be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc.

n. The Contractor’s striper shall be equipped with electrical foot counters. The counters shall individually tabulate the length of line applied by each gun whether solid or dashed. The Contractor shall determine the accuracy of the foot counters and establish an adjustment factor as required to determine the pay item quantities. The foot counters shall be periodically checked to assure accurate measurements. No thermoplastic shall be applied without the accurate operation of the foot counters. The Contractor shall provide the Engineer with a certified document on these calibrations.

2. Application Over Existing Markings

a. Existing thermoplastic markings on asphalt road surfaces may be over laid with thermoplastic material providing that the existing markings (thermoplastic) are less than 30 mils thick, and are securely bonded to the substrate. If the thermoplastic is greater than 30 mils, or not securely bonded to the substrate, then it shall be ground to 30 mils, or removed completely if not securely bonded to the road.

b. Existing solvent based paint on asphalt road surfaces may be over laid with thermoplastic provided that more than 75% of the road surface is exposed, and there is no more than a single coat of paint on the remaining unexposed area. If more than one layer of paint exists, the paint is not securely anchored to the substrate, or there is less than 75% of the road surface exposed, then the paint must be thoroughly removed.

c. All existing polyester, epoxy, or other type pavement marking paints on asphalt or concrete road surfaces must be completely removed from all road surfaces prior to the installation of thermoplastic material.

3. Application Temperatures: To insure optimum adhesion, the pavement and ambient air temperature shall be 50° F and rising. The thermoplastic material shall be applied in a melted state at a temperature of 400° F to 425° F. The temperature of the material within the shaping dies shall be maintained at the manufacturer's recommendations for application temperatures, but in no case shall the temperature fall below 400° F or exceed 450° F.

   The material shall not break down or deteriorate if held at the plastic temperature for a period of four (4) hours or by reason of three (3) reheatings to the plastic temperature (400^0 F to 425^0 F).

   Where manufacturer's application temperatures differ from those as specified, the manufacturer's temperatures shall apply upon approval of the Engineer.

4. Line Quality: The finished lines shall have well defined edges and be free of waviness. Pavement marking lines shall be straight or of uniform curvature and shall conform with the tangents, curves, and transitions as specified in the pavement marking standards and/or as directed by the Engineer.

5. Line Thickness: The minimum thickness of the lines as viewed from a lateral cross section shall be not less than 90 mil near the edges, or less than 125 mil at the center. Drop–on glass beads shall not be included in the measurement, or if so, then appropriate allowances shall be made for the added mil thickness. A device for gauging the installed material thickness shall be furnished to the Engineer as requested for use on the project. The gauge shall be easy to read and shall readily indicate excessive variations.

6. Clean Up: The Contractor shall be responsible for removing all pavement markings material spilled upon the roadway surface or adjoining area. The Contractor shall use methods acceptable to the Engineer for removing the spilled material.

7. Line Repair: Any pavement marking which is crossed by a vehicle and tracked shall be replaced and any subsequent marking made by the vehicle shall be removed by methods acceptable to the Engineer at no additional cost to the Owner.

C. Preformed Thermoplastic Pavement Markings: The markings shall be applied in accordance with the manufacturer's recommendations on clean and dry surfaces.

1. Asphalt: The materials shall be applied using the propane torch method recommended by the manufacturer. The material must be able to be applied at ambient and road temperatures down to 32° F without any preheating of the pavement to a specific temperature. The pavement shall be clean, dry and free of debris and oil or grease residue.

   a. At temperatures below 50° F, the preformed thermoplastic pavement markings shall be kept as warm as possible to maintain flexibility.
   b. Remove pavement surface moisture by holding a propane torch approximately 6 inches above the section of asphalt using a continuous circular motion.
   c. Heat the pavement with the torch upon placing the material to a temperature of 200° F for 90 mil, and up to 300° F for 125 mil materials.
   d. Immediately after the road surface has been properly preheated, position the material with exposed bead side up and heat.

e. Position the torch approximately 12-inches over the marking so the flame is extended and heat is evenly applied moving the torch in a circular motion across the marking. When the correct temperature of the marking has been reached, it will turn slightly darker or pale yellow if the material is white. Over heated or burned material shall be removed.

f. After the entire material section has been heated and bonded to the pavement, re–heat the perimeter of the marking and the road surface to bond the edges.

g. If installing reversible arrows, which do not contain a top coating of glass beads, the glass spheres shall be hand applied on the molten material.

h. Feather the leading edge of the pavement marking with a putty knife or bevel with the torch. Leading edges are any edge that would be susceptible to snow plow blades approaching from the direction of normal travel.

i. After cooling, use a putty knife to attempt to remove a portion of the material. The material shall not pry off without asphalt embedded to the underside.

2. Concrete: New concrete surfaces must be sandblasted to entirely remove curing compound. The same application procedure shall be used as described for asphalt pavements. However, a compatible primer sealer may be applied before application to assure proper adhesion.

3. Chip Seal Surfaces: The same application procedure shall be used as described for asphalt pavements. However, loose aggregate should be removed where the preformed thermoplastic pavement marking is to be applied.

D. Cold Plastic Pavement Markings: The Contractor shall furnish and install white and yellow permanent retro–reflectorized cold preformed plastic pavement marking material at the location shown on the Plans, in conformance with the material specifications included herein.

The cold plastic markings shall consist of a homogeneous, extruded, prefabricated material of specified thickness and width which shall contain reflective glass spheres uniformly distributed throughout the cross–section, and shall be applied only to concrete pavement surfaces by means of an approved inlaid grinding process with pre–coated adhesive and pressure.

1. Contractor's personnel: It is important that the Contractor's personnel be completely knowledgeable of all application requirements and procedures prior to product application. It is the responsibility of the Contractor to contact the supplier of the cold plastic material if questions regarding application procedures or conditions arise.

2. Procedure: This procedure explains how to apply tape to concrete surfaces only. Apply the tape according to manufacturer's instruction in conjunction with an approved inlaid grinding method.

3. Road conditions: It is recommended that the tape be installed as soon as practical following tape manufacturer instructions.

a. Cold plastic pavement markings shall be inlaid by an approved grooving process into concrete pavement surfaces. Cold plastic will not be allowed on asphalt pavement surfaces whether inlaid into hot asphalt or existing asphalt surfaces. Grooving the pavement surface allows preformed pavement marking tape to better adhere by creating a fresh surface. Grooving also produces a lower profile marking by embedding the tape into the pavement surface, which helps protect the tape from snowplow damage.

b. The cutting head shall consist of diamond tipped cutting blades "gang stacked" 0.25 inches to 0.50 inches wide. The spacers between each blade must be such that there is less than a 10 mil raise in the finished groove between the blades. Water–cooling the blades may be

necessary for long line grooving.

c. The groove width shall be equal to the tape width plus 1 inch ± 1/8 inch. The depth of the groove shall be 75% of the tape thickness ± 15%. For series 420, 60 mil tapes, the groove shall be 45 mils ± 10 mils or 0.05 inch ± 0.01 inch. The bottom of the groove should have a smooth, flat surface. If a coarse tooth pattern is present, increase the number of blades and decrease the thickness of the spacers between the blades on the cutting head. If water–cooling is used, flush the groove immediately after grooving to clean the surface.

d. Clean the surface of the road and the groove using a broom and/or high– pressure air blower. If either of these methods fail to clean the road surface, then high–pressure water wash shall be used. Road surface, including the surface of the groove must be dry and all dust, dirt, debris, oil, grease and foreign material removed before applying tape. If using water–cooling to groove, the groove must be completely dry prior to tape application.

4. Tape Application: If there is a crack in the pavement, or if the tape is to be applied over a bridge expansion joint, manhole or utility box, lay the tape over the crack joint or fitting, then cut the tape 1-inch away from the crack or joint on each side. Apply the required surface preparation adhesive and allow to dry completely (5–10 minutes at 70° F, but not over 30 minutes).

5. Tamping: Tamp the tape thoroughly with a tamping cart with a minimum 200 pound load, three times back and forth (six passes) over each part of the tape. Start in the center of the marking and work out to the edges removing any trapped air.

6. Do not twist or turn the tamper cart on the tape.

7. Make six passes (three passes back and forth) over each part of the tape (tamping is very important).

8. Make sure all edges are firmly adhered.

9. Application Conditions

   a. Air temperature 60° F and rising.
   b. Surface temperature 70° F and rising.
   c. Overnight air temperature 40° F the night before tape application.
   d. Pavement surface must be clean and dry. No rainfall should occur within 24 hours prior to application.
   e. Butt splices must be used; do not overlap tape ends.
   f. Traffic must be kept off of pavement surfaces coated with a surface preparation adhesive prior to tape application (follow manufacturer's instruction regarding the use of surface preparation adhesive).

10. Surface moisture: Cold preformed plastic tapes will not adhere if moisture is present. Therefore, road surfaces must be dry and above the minimum required temperature for application of all tapes. If rainfall occurs within 24 hours prior to application, a surface moisture test (plastic wrap or roofing paper method as approved by the Engineer) must be performed and approval obtained from the Engineer. The groove must be visibly dry for a minimum of two hours prior to application. A moisture test shall be completed after the two–hour drying time to ensure no presence of moisture.

E. Pavement Marking Paint: The Contractor shall furnish and install white and yellow retro–reflectorized pavement marking paint material at the location shown on the Plans, in conformance with the material specifications included herein.

1. The wet thickness and dry thickness of the pavement marking paint shall not be less than 15 mils and 12 mils, respectively without glass beads.

2. Glass beads shall be applied uniformly over the entire length of line at the rate of 6 to 10 lbs. per gallon of paint.

3. The gun tip shall be oriented perpendicular to the centerline to ensure that the beginning and ends of all lines are perpendicular to the centerline and not skewed.

4. The equipment shall be maintained such that the needle can be fully closed when shut as to ensure square cut lines at the beginning and ends.

F. Epoxy Pavement Marking: The Contractor shall furnish and install white and yellow epoxy markings at the location shown on the Plans, in conformance with the material specifications included herein.

1. Equipment

   a. Use equipment that is capable of spraying both yellow and white epoxy in the manufacturer's recommended proportions. Provide equipment that can place stripes on the left and right sides, and place two lines simultaneously with either line in a solid or intermittent pattern in yellow or white. All guns must be in full view of operators at all times. If words, symbols, crosswalks, cross–hatching and stop bars are to be of epoxy resin material, equip the truck with a hand spray wand for such application. Mount the equipment on a truck of sufficient size and stability, and with an adequate power source, to produce lines of uniform dimension and prevent application failure. Provide equipment with metering devices to register the accumulated volume dispensed for each material, each day. Additionally, provide individual pressure gauges, clearly visible to the operator, for each pump used.
   b. Provide equipment with two glass bead dispensers (double drop system) that uniformly distributes the glass beads to the surface of the epoxy pavement marking at a rate of at least 25 pounds per gallon. Glass beads may be applied by a pressure gun or controlled free fall.

2. Contractor's Personnel: Assure that at least one employee on the project when pavement markings are being applied holds an American Traffic Safety Services Association (ATSSA) pavement marking certification.

3. Surface Preparation

   a. On existing pavements, remove the existing pavement markings in accordance with these specifications. Remove the existing markings and prepare the surface according to the manufacturer's recommendations (for the type of markings being installed).
   b. On new Portland cement concrete pavement (PCCP), use shot blasting to remove curing compounds and laitance from the surfaces to which the pavement marking will be applied. Prepare the surfaces of new concrete bridge decks the same as new PCCP.
   c. On all pavements, thoroughly remove all dirt, grit, grease, grime, vegetable matter, residue of prior pavement marking application (including such adhesives or primers that may have been used in their application), and any other foreign matter from the roadway surface prior to the application of epoxy pavement markings.

4. Alignment: All layout required in the construction of the pavement marking is the responsibility of the Contractor. Lay out the pavement marking as detailed on the Plans. When the Plans do not provide details, submit a layout plan (conforming to the requirements of the Manual on Uniform Traffic Control

Devices (MUTCD)) for the pavement markings to the Engineer for approval. Normally locate longitudinal pavement marking stripes 2-inches from existing longitudinal joints. Provide adequate guide marks (approximately 2-inches by 6-inches at approximately 30 to 50 ft. intervals) for the application of the pavement markings.

5. Pavement Marking Application

   a. When no traffic is present, and for edge lines under any condition of traffic, a slower curing epoxy material (40 minutes) may be used. When the application is taking place under traffic, use a fast setting (10 minutes) epoxy material for center lines and skip lines.
   b. Apply the epoxy material closely behind the cleaning procedure.
   c. Provide the Engineer with a copy of the manufacturer's application instructions. Apply the epoxy pavement markings in accordance with the manufacturer's recommendations. In the absence of manufacturer's recommendations, apply the markings when the ambient and pavement surface temperatures are 50° F and rising. Cease pavement marking operations when the ambient or the pavement surface temperature drops to 50° F.
   d. Before mixing the components of the pavement marking material, heat the individual components to the temperature ranges recommended by the manufacturer of the material. Avoid exceeding the maximum recommended temperature at any time.
   e. Apply the epoxy pavement marking material at a thickness of 20 mils ± 0.2 mils on asphalt and PCCP. Immediately apply the glass beads to the epoxy pavement marking at the rate of 25 pounds per gallon of epoxy, equally divided between the large and regular bead gradations. Apply the large beads on the first drop and the regular beads on the second.

2306.9 Method of Removal

Temporary pavement markings on milled surfaces scheduled to be overlaid do not have to be removed prior to performing the overlay. Permanent pavement markings installed on new asphalt surfaces shall be removed without structurally damaging the pavement or scarring the surface. The method of pavement marking tape removal shall be by a high pressure water blast method, a low-pressure water and sand blast method, a steel shot blast method, or burning method. Grinding or black paint covering shall not be allowed on new pavement surfaces.

2306.10 Performance Measures

The Contractor shall remove and replace, at the Contractor’s expense, any finished markings that have the following deficiencies:

- Drag marks, gashes, gouges, pitting, foreign covering, discoloration, or areas that have failed to solidify
- Improper adhesion, length, width, or thickness
- Glass bead inadequacy
- Ragged appearance with areas that do not present sharply defined edges
- Deviation from the specified layout by an unreasonable amount based on Engineer’s judgment

Drippings between markings shall be removed when instructed by the Engineer and shall not result in visible deterioration of the pavement.

2306.11 Method of Measurement

Pavement Markings will be measured by one of the following:

A. Per linear foot of line. Skip lines are paid based upon length of marked section, 1-foot of a dual line is paid for at two unit feet bid.

B. Per each symbol.

2306.12 Basis of Payment

Pavement Markings will be paid for by one of the following:

A. Contract unit bid price.

B. Contract lump sum bid price.

SECTION 2307 FENCING

2307.1 Scope

This section governs the furnishing all labor, materials, and equipment for the for the installation and removal of fencing as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2307.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

MCIB Mid-West Concrete Industry Board Concrete Specifications - Concrete Pavement
The current editions of the "Bulletins" and Approved Sections of the "Standard Concrete Specifications" issued by the Mid-West Concrete Industry Board, Inc. (MCIB) are made a part hereof by reference. However, when the provisions of this Specification differ from the provisions of such "Bulletins" and "Sections" the provisions of this Specification shall govern.

KCMMB Kansas City Metro Materials Board Specifications

Kansas Department of Transportation
Standard Specifications for State Road and Bridge Construction, 2015 Edition
Section 828 – Fencing
Section 1620 – Material for Fencing

Missouri Highways and Transportation Commission
Missouri Standard Specifications for Highway Construction, 2011 Edition
Section 1043 Fence Materials
Section 607 Chain Link Fence

2307.3 Materials

A. All materials used for the installation of a permanent chain link fence shall be new material conforming to:

1. Missouri Projects: Section 1043 of the Missouri Standard Specification for highway construction except concrete for posts shall be MCIB Mix No. A543-1-4-0.479, approved KCMMB 4K mix, or approved

equal.

2. Kansas Projects: Section 1620 of the Kansas Standard Specifications for State Road and Bridge Construction except concrete for posts shall be MCIB Mix No. A543-1-4-0.479, approved KCMMB 4K mix, or approved equal.

B. All material used for the installation of permanent decorative fence shall be new material as specified or as shown on the Plans or that match the existing fence.

2307.4 Construction

A. Removal: Existing fence shall be removed as specified or as shown on the Plans or as directed by the Engineer. Removed fencing may be used for temporary fencing only with the Engineer's approval. Fences interfering with construction, and located within public right-of-way or as may be allowed for in permits or agreements, may be removed by the Contractor only if the opening is provided with a temporary gate that will be maintained in a closed position except to permit passage of equipment and vehicles unless otherwise specified. Fences within temporary construction easements may be removed by the Contractor provided that temporary fencing is installed in such a manner as to serve the purpose of the fencing removed. The Contractor shall locate and record all fence corners prior to removal. All fencing removed shall be restored by the Contractor to a condition equal to or better than that existing prior to construction unless otherwise specified. The Contractor is liable for loss and costs associated with stray animals caused by the removal or improper construction of temporary or permanent fencing.

B. Chain-Link Fence: Chain-Link Fence shall be installed at the locations shown on the Plans or as directed by the Engineer in accordance the applicable KDOT or MoDOT specifications for the state where the work is being performed. However, the bottom of the fabric shall be not more than 1 ½ inches above the finished ground line unless shown otherwise on the Plans. All residential fence shall have a top rail and all edges of fence fabric shall be knuckled.

C. Decorative Fence: Decorative fence shall be installed at the locations shown on the Plans or as directed by the Engineer in accordance with the manufacturer's instructions and recognized industry standards or as directed by the Engineer.

2307.5 Method of Measurement

A. Fence shall be measured along the slope of the fence to the nearest linear foot. Vehicle gates shall not be included in this measurement.

B. Gates: Gates shall be measured per each for the size and type specified.

C. Temporary Fence: Temporary fence will be measured by one of the following:

1. No measurement made.

2. Per foot measured along the slope to the nearest linear foot.

D. Fence Removal: Fence removal will be measured by one of the following:

1. No measurement made.

2. Per linear foot to nearest foot.

2307.6 Basis of Payment

All items in this section will be paid for at the respective Contract unit bid price. There will be no separate payment for pedestrian gates; they are subsidiary to the fencing pay item.

SECTION 2308 STEEL BEAM GUARDRAIL

2308.1 Scope

This section governs the furnishing all labor, materials, and equipment for the for the installation of Steel Beam Guardrail as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2308.2 Referenced Standards

ASTM
A 36 Standard Specification for Carbon Structural Steel
A 123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A 153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

AASHTO
M 180 Standard Specification for Corrugated Sheet Steel Beams for Highway Guardrail

2308.3 Materials

A. Steel Posts: All posts, terminal post connectors, and steel blocks for guardrail shall be formed from a structural steel meeting the requirements of ASTM A 36, and shall be galvanized in accordance with ASTM A 123.

B. Guardrail and Hardware: All guardrail and hardware shall conform to the requirements of AASHTO M 180 Class A, Type 1. Hardware shall be galvanized in accordance with ASTM A 153. Guardrail shall be galvanized with a minimum of 1.80 ounces of Zinc per sqft. All Zinc shall be “Prime Western” grade or better.

2308.4 Construction

A. Setting Posts: Posts shall be set to the depth and spaced at the intervals shown on the Plans or Standard Drawings. They shall be set vertical and true to line and grade. Steel posts may be driven by a power hammer or may be set in dug or bored holes of a size sufficient to permit thorough compacting of the backfill around the post. The backfill material shall be dry sand, placed in layers not exceeding 12 inches in thickness to a depth of 12 inches below the finished grade. After erecting and adjusting the rail to true line and grade, the sand backfill shall be compacted by flooding. The final 12 inches of backfill consisting of suitable earth material shall then be compacted in six inch lifts. Any "mushrooming" of the top of a post shall be removed and damaged spelter coating on posts shall be repaired by the zinc alloy stick method while the surface is heated to approximately 600° F. Other methods of repairing the spelter coating shall receive prior approval of the Engineer.

B. Erecting Guardrail: Bolt holes shall be shop punched. Field punching, reaming and drilling will not be permitted. Guardrail beams shall be spliced, only at posts by lapping in the direction of traffic, using the required number of splice bolts. Beams for twisted turned down terminal sections may be either field or shop twisted. Sufficient twist shall be introduced such that the beam shall retain the required shape in a relaxed condition. Beams to be

erected on a radius of 150 feet or less shall be shop-curved as shown on the Plans. Each end of every installation of guardrail shall have an end, bridge anchor, or terminal section of the design and type shown on the Plans or Standard Drawings. They shall be of the same material and shall be galvanized in accordance with the requirements for the guardrail beam. Galvanized rail shall be handled in a manner to avoid damage to the galvanized coating. Any sections of rail, end sections or terminal sections on which the spelter coating has been bruised or broken shall be rejected, or may with the prior approval of the Engineer, be repaired by the method prescribed for repairing damaged spelter coating of steel posts.

2308.5 Method of Measurement

Steel beam guardrail will be measured from center of terminal post to center of terminal post per linear foot and quarter part thereof.

2308.6 Basis of Payment

Payment will be made at the Contract unit or lump sum bid price. There will be no separate payment for terminal end sections except when specified in the Contract Documents.

END OF SECTION

SECTION 2400 – SEEDING AND SODDING

CITY OF LEE'S SUMMIT, MISSOURI
STANDARD SPECIFICATIONS

The City of Lee's Summit hereby adopts Section 2400 of the Kansas City Metropolitan Chapter of APWA Construction and Material Specifications, current edition**.**

DIVISION II
CONSTRUCTION AND MATERIAL SPECIFICATIONS
SECTION 2400 SEEDING, SODDING AND OVERSEEDING

APPROVED AND ADOPTED THIS 15th DAY OF FEBRUARY 2017

KANSAS CITY METROPOLITAN CHAPTER
OF THE AMERICAN PUBLIC WORKS ASSOCIATION

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SECTION 2400 GENERAL

2400.1 Scope

This section governs all general specifications necessary for installation of seeding, sodding, native grasses, hyrdroseeding and overseeding in accordance with the Standard Drawings, the specifications and Special Provisions.

The Contractor shall furnish all plants and materials and perform all operations in connection with the preparation, fertilizing, placing, watering, weeding, firming and establishment, of sodded and seeded areas (both temporary and permanent applications). All areas of established yards shall be restored by sodding unless otherwise approved by the Owner. The Contractor shall sod and/or seed disturbed areas where shown on the Plans or by field inspection, as required by the Storm Water Pollution Prevention Plan and pursuant to all permits, applicable federal and state laws. The Contractor shall be responsible for establishment of grass.

2400.2 Referenced Standards

APWA
2150 Erosion Control

Kansas Department of Transportation
Standard Specifications for State Road and Bridge Construction, 2015 Edition
KDOT Division 2100, and Division 900

Missouri Highways and Transportation Commission
Missouri Standard Specifications for Highway Construction, 2011 Edition
MODOT Section 800

Federal and State Department of Agriculture Regulations

Applicable State Weed Laws, Missouri Revised Statutes Chapter 263, and Kansas Statutes Annotated, Chapter 2. Article 13.

American Sod Producers Association (A.S.P.A.) “Specifications for Turfgrass Sod”, and “Specifications for Topsoil Material and Application”

2400.3 Definitions

A. Rough Grading is to mean the work necessary to prepare the subgrade for topsoil application and shall be compatible with the surrounding landscape while making a smooth tradition to existing undisturbed conditions.

B. Subgrade is to mean that level of earth below the topsoil layer.

C. Compacted backfill is to mean a compaction of 90 percent standard proctor density for that material.

D. Tolerance is to mean that amount above or below a given line.

E. Certified Sod: State Certified Sod shall be turfgrass sod, grown from certified high quality seed that has

been inspected by the State Certification Agency.

F. Certified Seed: A grass or legume seed named variety that has been reviewed and accepted and meets all state and federal requirements, rules and regulations. The seed shall be grown and processed in the United States or Canada and comply with the requirements of the corresponding State Seed Law. Certified Seed shall be packaged and labeled with an inspection certificate from the State Certification Agency stating genetic identity, purity, and freedom from noxious weeks as well as excessive amounts of other crop and weedy plants at time of harvest. Cleaning and conditioning of seed must result in a product that meets or exceeds minimum standards.

G. Establishment Period: A period when planting work has been performed and initially accepted, and there is a Contract requirement to care for the planted areas in some way until the period ends.

H. Fertilizer: The grade of fertilizer will be identified according to the percent nitrogen (N), percent of available phosphoric acid (P205), and percent water soluble potassium (K20), in that order, and approval will be based on that identification.

I. Native Plant (existing): A variety of plant species occurring in its natural habitat without direct or indirect human actions.

J. Noxious Weed: All weed designated by the State Weed Board as injurious to public health, agriculture, recreation, wildlife, or all public or private property. The United States Department of Agriculture (USDA) for the corresponding state will be the authority in determination of noxious weed species.

K. Pure Live Seed (PLS): The amount of living seed in the total quantity of seed when non-viable seed or non-seed material is excluded. The following formula shall be used to determine the amount of commercial seed required to provide each kind of seed for the specified quantities of pure live seeds:

$$\text{Pounds of Commercial Seed Required} = \frac{10{,}000 \times \text{Pure Live Seed (lbs per acre)}}{\text{Purity (Percent)} \times \text{Germination (percent)}}$$

L. Riparian: Related to the bank, shore, or water-influenced areas of a watercourse or water body.

M. Sensitive Areas: Defined areas such as wetlands, natural water and riparian resources, special environmental zones, or where certain activities are restricted such as the use of chemicals.

N. Specified Weeds: All noxious weeds as defined above, and all plant species identified in the Special Provisions or on the Plans as a species to be removed.

O. Weed: A plant that is undesirable where it is growing.

2400.4 Submittals

Prior to delivery to the job site, Contractor shall submit to the Owner for approval the source and supplier of all grass seed, sod, fertilizer and mulch materials, along with the type of equipment to be used on this project and any tests completed. Manufacturer's bulletins, leaflets and other descriptive data which contain cuts, dimensions, and specifications will be acceptable for cataloged materials. Such bulletins, leaflets and other descriptive data shall be clearly marked to show which item is to be used and which paragraph of the contract specification it is to satisfy.

2400.5 Protection and Repair

The seeded/sodded area shall be kept free of traffic until accepted. If at any time before acceptance of the completed contract, any portion of the seeded surface becomes gullied or otherwise damaged, or the seeding has been damaged or destroyed, the affected portion shall be repaired to re-establish the specified condition prior to the acceptance of the work.

2400.6 Acceptance of Seeding and Sodding

A. Acceptance: Acceptance by the Owner will occur when areas seeded and/or sodded are determined to be established turf areas ready for mowing. Grass areas in excess of one (1) square foot that are dead or in poor condition regarding color and quality shall be replaced at the Contractor's expense prior to the initiation of the Maintenance Period.

B. Sod Watering: Throughout the Maintenance Period, the Contractor shall be responsible for watering the installed sod until it is established and ready for mowing. In the absence of rainfall, watering shall be performed daily during the first week and shall be sufficient to maintain moist soil to a depth of at least 4 inches. Soil on sod pads shall be kept moist at all times. Watering may be done during the heat of the day to help prevent wilting. After the second week, the Contractor shall water the sod as required to maintain adequate moisture in the upper 4 inches of topsoil necessary for the promotion of deep root growth until final acceptance as established turf areas ready for mowing.

C. Seed Watering: The Contractor shall be responsible for watering seeded areas, keeping all areas moist throughout the germination period, following the substantial germination of the seed, and during the occurrence of a dry or drought period. Continued watering will be required until final acceptance as established turf areas ready for mowing.

D. Acceptance Notification: After acceptance of the seeded or sodded area by the Owner, the Contractor shall by door hangers or other approved methods, notify all affected property owners that the maintenance of the grassed areas is now their responsibility.

2400.7 Clean-up

During the progress of this work and upon completion, thoroughly clean the project area, remove and properly dispose of all resultant dirt, debris and other waste materials.

2400.8 Guarantee

The Contractor shall guarantee all work and materials for a period of one full growing season (Spring to Fall) after the date of final acceptance of the project. During the guarantee period, all turf which dies or exhibits weed growth or undesirable grasses, free of eroded areas, bare spots, diseases and insects, shall be replaced with like material at the expense of the Contractor. Contractor to replace as originally specified areas which have failed to survive, as often as required, to establish the seeded/sodded lawn area until accepted, at no additional compensation. Contractor to repair and replace to original condition all damages to property resultant from the sodding operation and all damages as a result from the remedying of these defects, without additional compensation.

SECTION 2401 SEEDING

2401.1 Scope

This section governs furnishing all labor, materials and equipment necessary for complete installation of seeding in

accordance with the Standard Drawings, the specifications and Special Provisions. The Contractor shall furnish all plants and materials and perform all operations in connection with the preparation, fertilizing, placing, watering, firming and establishment, of seeding areas, complete and in strict accordance with these specifications and applicable Plans, and subject to the terms and conditions of the Contract. The Contractor shall seed disturbed areas where shown on the Plans or by field inspection and as required by the Storm Water Pollution Prevention Plan. The Contractor shall be responsible for establishment of grass.

2401.2 Materials

A. Seed: Seed shall be labeled in accordance with U.S. Department of Agriculture Rules and Regulations under Federal Seed Act. All seed shall be furnished in sealed standard containers unless exception is granted in writing by the Owner. Seed shall be free from noxious weeds and recleaned "Grade A" recent crop seed treated with appropriate fungicide at time of mixing. Seed which has become wet, moldy, or otherwise damaged in transit or in storage will not be acceptable. Seed mix to be used will be identified prior to sowing. The minimum percentage by weight of pure live seed in each lot of seed shall be as follows:

1. Seeding – Mix #1 (Turf Areas)

   Festuca arundinacea, Fineleaf Tall Fescue. Varieties- Houndog V. Rebel Jr., Rebel III, Rebel 3D, Barlexas, Millennium, Southern Choice, Tar Heel, Wolf Pack, Bonsai 2000, Shortstop II Coyote, or other pre-approved substitutes 62.5%

   Poa pratensis, Kentucky Bluegrass. Varieties- Baran, Nassau, Ram I, Nublue, Rugby II, Award, Blacksburg, Challenger, Eagleton, Limousine, Livingston, Midnight, Nuglade, Preakness, Princeton 105, Quantum Leap, 1757 or other approved substitutes 25.0%

   Lolium multiflorum – annual ryegrass 12.5%

2. Seeding – Mix #2 (Low Use Areas)

   Fescure ovina, Sheeps Fescue. Varieties- Azay, Big Horn, or other pre-approved substitutes 15.0%

   Fescura rubra subsp. Commutata, Chewings Fescue, Varieties-James town II, Victory, Tiffany, or other approved substitutes 20.0%

   Fescuca longifolia, Hard Fescue. Varieties- Spartan, Tournament, Warwick, Discovery, Waldina, Aurora, 4 AG Attila, Reliant II, Scaldis, or other pre-approved substitutes 35.0%

   Fescuca ruba subp. Ruba, Creeping Red Fescue. Varieties- Shademaster II, Jasper, Cindy, Pennlawn, or other pre-approved substitutes 30.0%

3. Seeding Rate**:** Seed mixture shall be sown at the minimum rate of 10 pounds per 1000 square feet for new seeding. See Section 2406.3.E.1 for overseeding rates.

B. Inorganic Fertilizer**:** Inorganic fertilizer shall be composed of a formula 12-12-12, 13-13-13 or other approved substitute, and shall conform to the applicable State fertilizer laws. Fertilizer shall be of a type that can be uniformly distributed by the application equipment. Fertilizer may be furnished in a dry (granulated) or liquid form. When applied dry, the fertilizer shall be a granular, non-burning chemically combined product composed of not less than 50% organic slow acting, guaranteed analysis professional fertilizer. Granular or

pellet form shall be uniform in composition, dry and free flowing and shall be delivered to the site in the original unopened containers each bearing the manufacturer's guaranteed analysis. Any fertilizer which becomes caked or otherwise damaged, making it unsuitable for use, will not be accepted. When applied in a liquid form, fertilizer may be chemically combined or may be furnished as separate ingredients.

C. Mulch: Mulch shall be the vegetative type, or wood cellulose fiber type, whichever is specified in the Special Provisions, or as approved by the Owner.

1. Vegetative Type: The vegetative type shall be the cereal straw from stalks of oats, rye, wheat or barley and shall be free of prohibited and noxious weed seeds.

2. Wood Cellulose Fiber Mulch: Wood cellulose fiber shall contain no germination or growth inhibiting ingredients, and shall be dyed an appropriate color to aid in visual metering in its application. It shall be easily and evenly dispersed and suspended when agitated in water, and when sprayed uniformly on the soil surface, shall form a blotter-like cover, which readily absorbs the water and allows infiltration to the underlying soil. The mulch material shall be supplied in packages of not more than 100 pounds gross weight, and shall be marked by the manufacturer to show the air dry weight content (air dry weight shall contain no more than 10 percent moisture).

D. Water: Water, hose and other watering equipment required for the work shall be furnished by the Contractor.

E. Other Materials: Other materials not specifically described but required for a complete and proper planting installation, shall be as selected by the Contractor subject to the approval by the Owner.

F. Equipment: The seeding operation shall be accomplished with equipment suitable for preparing the seed bed, sowing the seed, fertilizing, spreading the vegetative type mulch, or spreading the wood cellulose fiber mulch in accordance with the applicable requirements of the following sub-section entitled "Construction".

G. Top Soil: The Contractor shall make every reasonable effort to stockpile existing top soil prior to excavation and reuse it in the same general locations. No payment will be made for topsoil furnishing and placement necessary due to excessive hauling off of existing top soil on the project site.

H. Qualifications of Workman: Provide at least one person, who shall be present at all times during the execution of this work, who is thoroughly familiar with all materials and installation procedures included in the Sodding and Seeding operations as specified herein.

I. Delivery Containers: Deliver all items to the site in their original containers with all labels intact and legible at time of Owner inspection.

J. Protection: Use all means necessary to protect all materials before, during and after installation, and to protect the installed work and materials of all other trades.

K. Replacements: In the event of damage or rejection, immediately make all repairs and replacements to the approval of the Owner and at no additional cost to the Owner.

L. Weather Conditions: All sodding and seeding shall be performed during favorable weather conditions and only during normal and acceptable planting seasons when satisfactory growing conditions exist. The planting operations shall not be performed during times of extreme drought, when ground is frozen or during times of other unfavorable climatic conditions unless otherwise approved by Owner. The Contractor assumes full and complete responsibility for all such plantings and operations.

M. Planting Dates: Recommended dates for all seeding and planting shall be March 15 through October 15 unless otherwise approved by the Owner.

N. Pre-planting Inspection: Prior to the work of this section, the Contractor shall carefully inspect the installed work of all other trades and verify that all such work is complete to the point where installation may properly commence.

O. Discrepancies: Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

2401.3 Construction

A. All equipment used in the project and all workmanship shall meet the approval of the Owner.

B. All areas to be seeded shall be tilled or disked to a depth of 3-4 inches and raked or smoothed to remove debris, clods, surface stone, 2-inches diameter or larger and weeds. Grades on the areas to be sodded or seeded shall be maintained in true, even and compacted conditions to prevent the formations of depressions. Areas overseeded, to be seeded that have washed or eroded shall be brought to grade and compacted thoroughly by the Contractor prior to placing the seeding or overseeding. No grading shall be done when the soils are in a muddy or frozen condition.

C. Steel Edging: The finish sub-grade of areas to be planted shall be 2" below top of steel edging, if present, for grass sod and flush with top of steel edging for seeding.

D. Other Edges: The finished sub-grade next to curbs, sidewalk and drive approaches shall allow for the seed to be placed level with the improvement. The sub-grade shall be finished level with the improvement for seeding.

E. Fertilizer Application: For areas to be seeded, fertilizer shall be applied when area receives final grading and tillage.

F. Application of Fertilizer: The Contractor has the option to obtain soil tests from a recognized testing laboratory, approved by Owner, to determine soil pH, nitrogen, phosphorus and potassium requirements and organic matter content. A pH or 5.8 to 7.0 and phosphorus and potassium levels of medium or higher range for the particular test used is required. Soils falling below these test levels must be supplemented with the appropriate materials to meet such test levels. If the above soil test is not performed a 13-13-13 fertilizer shall be applied at the rate of 400 pounds per acre.

G. Acceptance of Plant Bed: Acceptance of the plant bed for seeding shall be obtained from the Owner for each section of area as indicated on the Plans. The Contractor shall be responsible for maintaining the accepted areas until the effective date for planting.

H. Sowing shall be accomplished by use of an approved mechanical seeder or drill (hand spreader can be used in small areas), making sure that successive seed strips overlap to provide uniform coverage. Seed should be drilled to a depth of 1/2 inch.

1. Seed mixed in proportions shown in Section 2405.2 may be broadcast by approved sowing equipment. The seed shall be uniformly distributed over the designated areas. The seed shall be covered to an average depth of ½ inch by means of a brush harrow, spike-tooth harrow, chain

harrow, cultipacker or other approved device.

2. Areas to be seeded shall be fertilized at rates specified in Section 2401.3.F. The seedbed shall be free of any irregularities in the surface, and shall be corrected in order to prevent formation of water pockets. All seeded areas are to be completely covered with hydromulch or with straw anchored to the soil a minimum depth of 3 inches by a disc harrow set nearly straight, to properly maintain soil moisture and to provide shade for the newly germinated chutes.

3. Promptly after mulching, wet the seedbed thoroughly, keeping all areas moist throughout the germination period. Protect all turf areas by erecting temporary fences, barriers, signs, etc. as necessary to prevent trampling and disturbance.

4. When delays in operations carry the work beyond the most favorable planting season for the grasses designated, or when conditions are such, by reason of drought, high winds, excessive moisture, or other factors that satisfactory results are not likely to be obtained, the seeding operation shall be stopped and work shall be resumed only when conditions are favorable again or when approved alternative or corrective measures and procedures have been put into effect. If inspection during seeding operations or after indicate there are areas which have been skipped, the sowing of additional seed on these areas will be required.

5. The seeded areas will be inspected for acceptable grass coverage and will be acceptable when grasses designated are growing and are in good condition and no area more than ½ of one percent of the total areas shall be bare, of which no single area shall be more than one foot square in area. Any bare area larger than this will not be acceptable and shall be reseeded.

I. Compaction: Immediately following the completion of seeding operations, the entire area shall be compacted by means of a roller weighing at least 60 but not more than 90 pounds per linear foot of roller.

J. Maintenance Period: The Contractor shall be responsible for maintaining the installed grass seed and sod until all areas are complete and accepted by the Owner.

K. Mulching: Mulching shall be done within 24 hours following the seeding operation except in the case of wood cellulose fiber type mulch.

1. Vegetative Type Mulch: After compacting the surface, mulch shall be uniformly spread at the rate of 1.5 tons per acre by means of a mechanical spreader or other approved means. As soon as the mulch is spread it shall be anchored to the soil a minimum depth of 3 inches by use of a heavy disc harrow, set nearly straight, or a similar approved tool. Discs of the anchoring tool shall be set approximately 9 inches apart. Anchoring shall be accomplished by not more than two passes of the tool.

2. Wood Cellulose Fiber Type: Wood cellulose fiber mulch shall be added to the hydraulic seeder after the proportionate amounts of seed, fertilizer and water, and other approved materials are added. These ingredients shall be mixed to form a slurry which shall be applied at the rate of 1,000 pounds per acre. The mulch shall make a uniform coverage of the soil surface that will be satisfactory to the Owner.

SECTION 2402 SODDING

2402.1 Scope

This section governs the furnishing all labor, materials and equipment necessary for complete installation of sodding, in accordance with the Standard Drawings, the specifications and Special Provisions.

2402.2 Materials

A. Sod: All grass sod shall be State Certified, nursery grown native mixture of Houndog, Rebel, Pride, Cochise, Coyote or other substitute, as may be approved. Sod shall be a Tall Turf type Fescue with 10 percent Bluegrass that is free of objectionable grassy and broadleaf weeds. Sod shall be considered free of such weeds if less than 5 such plants are present per 100 square feet of area. Sod will not be acceptable if it contains any of the following weeds: Common burmudagrass,(wiregrass), quackgrass, johnsongrass, poison ivy, nutsedge, mumblewill, Canada thistle, bindweed, wild garlic, ground ivy, perennial sorral and bromegrass, or as defined by current weed laws.

1. Pad Size: The sod shall be cut to supplier's standard width and length but not less than 12 x 24 inches and not more than 24 x 72 inches or bigger sizes that are approved by the Owner. There shall not be broken pads, torn or uneven ends.

2. Strength: Root development shall be such that standard size pieces will support their own weight and retain their shape when suspended vertically from a firm grasp on the uppermost 10% of area.

3. Mowing Height: Before harvesting sod, it shall be mowed uniformly at a height of 2 - 2½ inches. The sod shall be stripped or harvested by machine at a uniform thickness of 1½ inches ± ¼ inch. Measurement of thickness shall exclude top growth and thatch.

B. Fertilizer: Fertilizer shall be inorganic 12-12-12 or 13-13-13 grade, uniform in composition, free flowing and suitable for application with approved equipment, delivered to the site in convenient containers, each fully labeled, conforming to applicable state fertilizer laws, bearing the name, trade name, or trademark and warranty of the producer.

C. Top Soil: The Contractor shall make every reasonable effort to stockpile existing top soil prior to excavation and reuse it in the same general locations. No payment will be made for topsoil furnishing and placement necessary due to excessive hauling off of existing top soil on the project site.

D. Qualifications of Workman: Provide at least one person, who shall be present at all times during the execution of this work, who is thoroughly familiar with all materials and installation procedures included in the Sodding and Seeding operations as specified herein.

E. Delivery Containers: Deliver all items to the site in their original containers with all labels intact and legible at time of Owner inspection.

F. Protection: Use all means necessary to protect all materials before, during and after installation, and to protect the installed work and materials of all other trades.

G. Replacements: In the event of damage or rejection, immediately make all repairs and replacements to the approval of the Owner and at no additional cost to the Owner.

H. Weather Conditions: All sodding and seeding shall be performed during favorable weather conditions and only during normal and acceptable planting seasons when satisfactory growing conditions exist. The planting operations shall not be performed during times of extreme drought, when ground is frozen or during times of other unfavorable climatic conditions unless otherwise approved by Owner. The Contractor

assumes full and complete responsibility for all such plantings and operations.

I. Planting Dates: Recommended dates for all seeding and planting shall be March 15 through October 15 unless otherwise approved by the Owner.

J. Pre-planting Inspection: Prior to the work of this section, the Contractor shall carefully inspect the installed work of all other trades and verify that all such work is complete to the point where installation may properly commence.

K. Discrepancies: Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

2402.3 Construction

A. Sod shall not be harvested or delivered when excessively wet or dry. Sod shall be harvested, delivered and installed within a period of 36 hours. Protect sod from sun, wind, dehydration, and rain prior to installation that cannot be placed immediately on delivery. Sod showing visible signs of heating or dehydration will be rejected.

B. Areas to be sodded shall be fertilized at the rates specified in Section 2401.3.F. The sod-bed shall be free of any irregularities in the surface resulting from fertilizing or other operations and shall be corrected in order to prevent the formation of water pockets. Freshly graded areas, which have set long enough to become dry and crusted over, shall be tilled as specified above, prior to placing the sod.

C. The first row of sod should, if possible, be laid in a straight line with subsequent rows placed parallel and tightly against one another. Lateral joints shall be staggered as in brick laying to promote more uniform growth and strength. Care shall be exercised to ensure that the sod in not stretched or overlapped and that all joints are butted tight in order to prevent voids which would otherwise cause air drying of the roots. Where new sod meets existing grassed areas, a straight, vertical edge shall be cut to allow smooth match. Sod shall be watered and firmed in accordance with Section 2400.6.B. If it is necessary to walk excessively on newly laid sod or soil, walking boards should be laid for this purpose.

D. Sod shall be laid with staggered joints and at right angles to direction of slope. Sod shall be secured by tamping or rolling. On slopes 4:1 or steeper and in drainage channels, all sod shall be anchored at minimum two-foot intervals to prevent movement under rainfall conditions.

E. The Contractor shall be responsible for having adequate water available at the site prior to and during the installation of the sod and the areas to be seeded. The sod shall be watered immediately after installation to prevent drying during progress of the work. As sodding is completed on any one section, the entire area shall be thoroughly irrigated to a one inch depth below the new sod pad. After a short drying period, the sod shall be rolled with a roller weighing not less than 60 or more than 90 pounds per linear foot to firm the sod pad and smooth minor surface irregularities. Subsequent watering should maintain sod and soil moisture to a depth of at least four inches, supplement rainfall, to promote growth, promote proper rooting to insure sod survival, and to prevent dormancy.

F. Apply second application of fertilizer at the rate of 300 pounds per acre two weeks after laying sod and prior to final acceptance.

G. The sodded areas will be inspected for the acceptable grass coverage and will be acceptable when grasses designated are growing and are in good conditions, and no area more than ½ of one percent of the total

area shall be bare or dead, of which no single area shall be more than one foot square in area. Any bare or dead area larger than this will not be acceptable, and shall be resodded.

H. Maintenance Period – The Contractor shall be responsible for maintaining the installed grass seed and sod until all areas are complete and accepted by the Owner.

I. Maintenance of sodded areas shall include watering, weeding, mowing to a 2½ inch height after growth has exceeded 3 inches and prior to a 4 inch growth, replacement and installation of sod as originally specified for sodded areas failing to survive, and repair of rutting, should that occur. Clippings from mowing which mat on the grass are to be removed.

SECTION 2403 NATIVE GRASSES

2403.1 Scope

This section governs the furnishing all labor, materials and equipment necessary for complete installation of native grasses, in accordance with the Standard Drawings, the specifications and Special Provisions.

2403.2 Materials

Furnished and installed per Section 2403.3. Annual plants which sprout rapidly and survive for only one growing season are suitable only for establishing temporary vegetative cover. See Temporary Seeding, Section 2153.5.

A. The seed mix will be as follows:
Short-grass Mix
Seeding Rate: 6.42 lb/Acre (40.3 Seeds/ft2)

GRASSES:				
SCIENTIFIC NAME	COMMON NAME	% of Mix	Seeds/ft^2	Rate/Acre
Bouteloua curtipendula	Sideoats Grama	18.69%	2.6	1.200 PLS lb
Elymus canadensis	Canada Wild Rye	9.35%	1.1	0.600 PLS lb
Koeleria cristata	June Grass	1.56%	7.3	0.100 PLS lb
Schizachyrium scoparium	Little Bluestem	34.27%	12.1	2.200 PLS lb
Sporobolus aspera	Rough Dropseed	6.23%	4.4	0.400 PLS lb
Sporobolus cryptandrus	Sand Dropseed	0.31%	2.6	0.020 PLS lb
Sporobolus heterolepsis	Prairie Dropseed	0.16%	0.1	0.010 PLS lb

WILDFLOWERS:					
SCIENTIFIC NAME	COMMON NAME	% of Mix	Seeds/ft^2	Rate/Acre	
Aster laevis	Smooth Blue Aster	0.31%	0.4	0.020	PLS lb
Astragalus canadensis	Canada Milk Vetch	1.56%	0.6	0.100	PLS lb
Chamaecrista fasciculata	Partridge Pea	6.23%	0.4	0.400	PLS lb
Dalea candidum	White Prairie Clover	0.93%	0.4	0.060	PLS lb
Dalea purpurea	Purple Prairie Clover	6.23%	2.6	0.400	PLS lb
Desmanthus illinoensis	Illinois Bundle Flower	7.79%	0.8	0.500	PLS lb
Desmodium canadense	Showy Tick Trefoil	0.93%	0.1	0.060	PLS lb
Lespedeza capitata	Round-headed Bush Clover	0.31%	0.1	0.020	PLS lb
Ratibida pinnata	Yellow Coneflower	3.12%	3.1	0.200	PLS lb
Rudbeckia hirta	Black-eyed Susan	2.02%	1.5	0.130	PLS lb

2403.3 Construction

A. Prior to planting the topsoil in the disturbed area shall be tilled to 6 inches and compacted to approximately 80% density.

B. Native grass seed shall be installed using a rangeland type grain drill seeder per the rates stated. Depths of seeding plants should be ½ inch.

C. Spread and crimp 2,000 lbs. per acre of clean straw or hay within seven days of seeding.

D. Contractor shall provide a minimum of one watering after planting to establish the cover crop.

E. Cover crop shall provide 70% cover within 21 days of seeding.

F. Contractor shall guarantee that seeded areas will have 80% cover within two full growing seasons.

G. Contractor shall allow one application of selective herbicides in the spring to control weeds.

H. Care must be taken to comply with manufacturers labels.

SECTION 2404 HYDROSEEDING

2404.1 Scope

This section governs furnishing all labor, materials and equipment necessary for complete installation of

hydroseeding, in accordance with the Standard Drawings, the specifications and Special Provisions. Seed and fertilizer, mixed in proportions previously specified, may be broadcast in a hydromulch with water which forms an emulsion and covers the prepared designated areas in a uniform manner.

2404.2 Materials

Areas to be hydroseeded shall be fertilized at rates specified in Section 2401.3.F. The seed-bed shall be free of any irregularities in the surface, and shall be corrected to prevent formation of water pockets. Hydromulch used shall be a wood fiber mulch with tackifier, such as Conwit 2000, or approved equivalent. Hydromulch shall be applied at the rate of 1500 lbs. per acre.

2404.3 Construction

A. Seed and fertilizer, mixed in proportions previously specified, may be broadcast in a hydromulch with water which forms an emulsion and covers the prepared designated areas in a uniform manner.

B. Areas to be hydroseeded shall be fertilized at rates specified in Section 2406.3. The seed-bed shall be free of any irregularities in the surface, and shall be corrected to prevent formation of water pockets.

C. Hydromulch used shall be a wood fiber mulch with tackifier, such as Conwit 2000, or approved equivalent. Hydromulch shall be applied at the rate of 1500 lbs. per acre.

D. Hydroseeder filling tank should be ½ full of water before adding seed, fertilizer and hydromulch components. Begin agitation while adding remaining water so that a uniform mixture is obtained. Seed, fertilizer and hydromulch components shall not be added to water more than four (4) hours prior to application.

E. Discharge hydromulch slurry mix on prepared soil for uniform distribution.

F. Keep all areas seeded moist throughout germination period. Protect all turf areas by erecting temporary fences, barriers, signs, etc. as necessary to prevent trampling and disturbance.

G. The seeded areas will be inspected for acceptable grass coverage and will be acceptable when grasses designated are growing and are in good condition and no area more than ½ of one percent of the total areas shall be bare, of which no single area shall be more than one foot square in area. Any bare area larger than this will not be acceptable and shall be reseeded.

H. Contractor shall provide a minimum of one watering after planting to establish the cover crop.

I. Cover crop shall provide 70% cover within 21 days of seeding.

J. Contractor shall guarantee that seeded areas will have 80% cover within two full growing seasons.

K. Contractor shall allow one application of selective herbicides in the spring to control weeds.

L. Care must be taken to comply with manufacturers labels.

SECTION 2405 OVERSEEDING

2405.1 Scope

This section governs the furnishing all labor, materials and equipment necessary for complete installation of overseeding in accordance with the Standard Drawings, the specifications and Special Provisions. Overseeding is the planting of grass seed directly into the existing turf, without tearing up the turf, or the soil.

2405.2 Materials

All designated existing turf areas being overseeded shall use seed previously specified at the rate of 160 pounds per acre in a uniform manner. Areas to be overseeded shall be fertilized at rates previously specified.

2405.3 Construction

A. The seed-bed shall be free of any irregularities in the surface, and shall be corrected in order to prevent formation of water pockets.

B. Seed shall be applied with a seed drill. The seed drill shall verticut the soil to a minimum depth of ½ inch at not more than 1½ inch spacing between furrows.

C. Areas that have washed or eroded shall be brought to grade and compacted prior to overseeding.

D. The seeded areas shall be inspected for acceptable grass coverage and will be acceptable when grasses designated are growing and are in good condition. Not more than ½ of one percent of the designated turf area shall be bare, of which no single area shall be more than one foot square in area. Any area left unseeded larger than this will not be acceptable, and be reseeded.

SECTION 2406 MEASUREMENTS AND PAYMENTS

2406.1 General

There will be no measurement or separate payment for any items of work not specifically identified and listed in the Contract Documents and all costs will be included in the Contract unit prices for other items listed in the Contract Documents.

2406.2 Methods of Measurement

The quantities of accepted work shall be measured or determined as follows:

A. Seeding

1. Seeding will be measured per acre or hundredth part thereof. Seeding will be measured complete, in-place, to the nearest acre. No measurement will be made in areas that are not grassed, such as street paving, driveways, parking areas, gardens, and sidewalks. Areas that are disturbed which lie outside the Contractor's seeding limits, as defined by the Plans or Contract Documents, will not be measured for payment, but shall be restored to a condition equal to or better than that existing prior to construction.

2. Sanitary Sewer Project Construction: Seeding will be measured horizontally in linear feet along the centerline of sewer, regardless of the width of disturbed areas or type of seed used. Seeding will be measured only when centerline of sewer lies in grassed areas to be seeded as shown on the Plans. When centerline of sewer lies in areas that are not grassed, such as street paving, driveways,

parking areas, gardens, etc., no measurement will be made. Areas that are disturbed which lie outside the Contractor's normal trenching operation areas will not be measured for payment, but shall be restored to a condition equal to or better than that existing prior to construction. Each area measured will be measured either as seeding or sodding, but not as both. When sewer ends in grassed area, measurement will be made only to centerline of manhole.

3. Horizontal in linear feet along the back of curb (edge of pavement) regardless of the width of disturbed areas or type of seed used. Measurement will be made on each side of the roadway. No measurement will be made through or along intersecting roadways, drive approaches or similar structures.

4. No measurement in field, per Contract unit quantity only.

B. Sodding

1. Sodding will be measured per square yard or tenth part thereof. Sodding will be measured complete, in-place, to the nearest acre. No measurement will be made in areas that are not grassed, such as street paving, driveways, parking areas, gardens, and sidewalks. Areas that are disturbed which lie outside the Contractor's seeding limits, as defined by the Plans or Contract Documents, will not be measured for payment, but shall be restored to a condition equal to or better than that existing prior to construction.

2. Sanitary Sewer Project Construction: Sodding will be measured horizontally in linear feet along the centerline of sewer. Regardless of width of disturbed areas or type sod used. Sodding will be measured only when centerline of sewer lies in grassed areas to be seeded as shown on the Plans. When centerline of sewer lies in areas that are not grassed (such as street paving, driveways, parking areas, gardens. etc.) no measurement will be made. Areas that are disturbed which lie outside the Contractor's normal trenching operation areas will not be measured for payment, but shall be restored to a condition equal to or better than that existing prior to construction. Each area measured will be measured as either seeding or sodding, but not as both. When sewer ends in grassed area, measurement will be made only to centerline of manhole.

3. Horizontal in linear feet along the back of curb (edge of pavement) regardless of the width of disturbed areas or type of sod used. Measurement will be made on each side of the roadway. No measurement will be made through or along intersecting roadways, drive approaches or similar structures.

4. No measurement in field, per Contract unit quantity only.

2404.3 Basis of Payment

Payment for seeding and sodding will be paid for at the Contract Unit Prices as listed in the Unit Prices Bid Form. Such payment and price shall constitute full compensation for all labor, materials, tools and equipment necessary to complete the item.

The following items are considered subsidiary to the “Seeding” and “Sodding” pay items and no additional payment will be provided: Soil Preparation, Scalping of Existing Vegetation, Top Soil, Fertilizer, Mulch, Watering, Seed, Compaction, Maintenance, Protection and Repair, and Clean-up.

END OF SECTION

SECTION 2600 - STORM SEWERS

CITY OF LEE'S SUMMIT, MISSOURI
STANDARD SPECIFICATIONS

The City of Lee's Summit, Missouri's hereby adopts Section 2600 of the Kansas City Metropolitan Chapter of APWA Construction and Material Specifications, current edition. The following additions, deletions and/or revisions are adopted as a part of Section 2600 for use within Lee's Summit, Missouri.

2602.2 Materials
Delete Paragraph B and replace with the following:

Corrugated metal pipe shall not be used in the construction of public infrastructure. Storm drainage systems to remain privately owned and maintained may use corrugated Aluminized Steel Pipe

2602.2 Materials:
ADD the following

G. Polypropylene Pipe

1. ***Double wall polypropylene pipe shall have a smooth interior and annular exterior corrugations and conform to ASTM F2881 and AASHTO M330. Triple wall polypropylene pipe shall have smooth interior and exterior surfaces with inner corrugations and conform to ASTM F 2764. The pipe shall not be perforated unless otherwise specified.***
2. ***Pipe shall be joined with a gasketed integral bell and spigot joint meeting the requirements of ASTM F2881 for double wall pipe or ASTM F2764 for triple wall pipe.***
3. ***Coupling bands shall cover at least two full corrugations on each section of pipe and shall prevent the infiltration of soil into the pipe.***

2602.3 Construction:

2602.3.B.5.d Structure Connections – Laying and Jointing
REVISE to read as follows:

> Pipes connected to structures shall be cut parallel with the inside face of the structure for structures having plane walls and parallel with the spring line of the pipe for structures having curved walls. Projection of the pipe beyond the inside face shall not exceed ***3 inches*** (measured at the springline for structures having curved walls). ***When installed, all gaps and openings intended to be closed, shall be sealed with grout, concrete or other approved material.***

2604.2 Materials (for storm sewer structures):

2604.2.A – Concrete Mixes

REVISE to read as follows:

> ***"Concrete for structures and structural components shall be KCMMB 4k or 5k mix; or MCIB 4,500 psi or 5,000 psi mix. Nominal aggregate shall be 1-inch or larger. Concrete used for soil stabilization, pipe cradles, filling, leveling courses and other similar purposes may use smaller nominal aggregate sizes of 1/2-inch, 3/4-inch."***

2604.2 F – Manhole Castings and Metal Castings:
ADD the following

> ***3. Metal Castings shall be selected from the current City of Lee's Summit Public Works Approved Products List.***

2604.3 Construction (for storm sewer structures):

2604.3.A.2 Finishing:
ADD the following

c. If an adjustment is required for the top slab which is less than or equal to 6 inches, the adjustment shall be made with non-shrink grout with a coating of cement on both faces, if the adjustment is greater than 6 inches, the adjustment shall be made with dowelled concrete. Dowels shall be bars embedded 6 inches into the walls. All reinforcement shall be the same size and spacing as the wall steel.

ADD the following:

> ***2604.3.D. Cast-in-Place Box Culvert Support Slab:***
> ***Cast in place box culverts shall have a 3 inch thick grade slab cast under the bottom slab. The grade slab shall be at least as wide as the structure and shall stop short of the toe walls. Commercial grade concrete may be used with minimum 2500 psi compressive strength. The slab should be set with proper grade control to match the elevations required for the culvert.***

DIVISION II
CONSTRUCTION AND MATERIAL SPECIFICATIONS
SECTION 2600 STORM SEWERS

APPROVED AND ADOPTED THIS 15th DAY OF FEBRUARY, 2017
Last Revised March 3, 2020 (See underlined text, pg.16)

KANSAS CITY METROPOLITAN CHAPTER
OF THE AMERICAN PUBLIC WORKS ASSOCIATION

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SECTION 2601 GENERAL

2601.1 Scope

This section governs the furnishing all labor, materials, and equipment necessary for the complete installation of storm sewers and appurtenances as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions. Unless otherwise noted within these specifications, the word “sewers” shall refer to pipe sewers, box culvert sewers, or open channels.

2601.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards exist, the more stringent standard shall apply.

APWA

Section 2100	Grading and Site Preparation
Section 2150	Erosion and Sediment Control
Section 2200	Paving
Section 2300	Incidental Construction
Section 2400	Seeding and Sodding

ASTM

A 48	Standard Specification for Gray Iron Castings
A 139	Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)
A 153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A 240	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
A 615	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
A 641	Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
A 742	Standard Specification for Steel Sheet, Metallic Coated and Polymer Precoated for Corrugated Steel Pipe
A 744	Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service
A 745	Standard Practice for Ultrasonic Examination of Austenitic Steel Forgings
A 760	Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
A 761	Standard Specification for Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches
A 788	Standard Specification for Steel Forgings, General Requirements
A 929	Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe
A 1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
C 33	Standard Specification for Concrete Aggregates
C 76	Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
C 88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
C 361	Standard Specification for Reinforced Concrete Low-Head Pressure Pipe
C 443	Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
C 478	Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
C 506	Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
C 507	Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
C 923	Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals

C 990 Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
C 1628 Standard Specification for Joints for Concrete Gravity Flow Sewer Pipe, Using Rubber Gaskets
D 1683 Standard Test Method for Failure in Sewn Seams of Woven Apparel Fabrics
D 2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
D 3350 Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
D 3887 Standard Specification for Tolerances for Knitted Fabrics
D 5034 Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)
F 593 Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
F 594 Standard Specification for Stainless Steel Nuts
F 2306 Standard Specification for 12 to 60 in. [300 to 1500 mm] Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications
G 152 Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

AASHTO
M 31 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
M 36 Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drain
M 55 Standard Method of Test for Steel Welded Wire Reinforcement, Plain, for Concrete
M 196 Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
M 197 Standard Specification for Aluminum Alloy Sheet for Corrugated Aluminum Pipe
M 245 Standard Specification for Corrugated Steel Pipe, Polymer-Precoated, for Sewers and Drains
M 246 Standard Specification for Steel Sheet, Metallic-Coated and Polymer-Precoated, for Corrugated Steel Pipe
M 274 Standard Specification for Steel Sheet, Aluminum-Coated (Type 2), for Corrugated Steel Pipe
M 294 Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter

ANSI/AWWA
C 206 Field Welding of Steel Water Pipe

ACI 301 Specifications for Structural Concrete

Federal Standard 595B

MCIB Mid-West Concrete Industry Board Concrete Specifications - Concrete Pavement
The current editions of the "Bulletins" and Approved Sections of the "Standard Concrete Specifications" issued by the Mid-West Concrete Industry Board, Inc. (MCIB) are made a part hereof by reference. However, when the provisions of this Specification differ from the provisions of such "Bulletins" and "Sections" the provisions of this Specification shall govern.

KCMMB Kansas City Metro Materials Board Specifications

Kansas Department of Transportation
Standard Specifications for State Road and Bridge Construction, 2015 Edition

Missouri Highways and Transportation Commission
Missouri Standard Specifications for Highway Construction, 2011 Edition

2601.3 Cleanup

Cleanup shall follow the work progressively. The Contractor shall remove from the project site all rubbish, equipment, tools, surplus or discarded materials, and temporary construction items.

Streets to be opened to local traffic at the end of the day's operation shall be cleaned of dirt or mud. All equipment and material stockpiles shall be secured for safe passage of vehicles and pedestrians. If streets are to remain open to traffic, cleaning shall be performed at a minimum of once per day at the end of the day's work or as directed by the Engineer or Owner.

Clean-up shall be considered subsidiary to other items in the Contract Documents.

SECTION 2602 PIPE SEWER CONSTRUCTION

2602.1 Scope

This section governs the furnishing of all labor, materials and equipment for the construction of pipe storm sewers and appurtenances at the location and to the lines and grades indicated on the Plans.

2602.2 Materials

A. Reinforced Concrete Pipe

1. Pipe: Reinforced concrete pipe shall conform to the following ASTM Standards and be of the minimum strength designated herein or such higher strength as may be required by the Plans:

   a. Round Pipe: ASTM C 76, Class III (minimum), Wall B (minimum)
   b. Arch Culvert Pipe: ASTM C 506, Class A-III
   c. Elliptical Pipe: ASTM C 507, Class HE-III

   Except for fittings and closure pieces, each joint of pipe shall not be less than eight feet long for pipe diameters 48 inches or less and shall not be less than six feet long for pipe diameters larger than 48 inches.

2. Reinforcement: Circumferential reinforcement shall be full-circle type. Part-circle reinforcement will not be approved. All reinforcing shall be located and spaced as recommended by the pipe manufacturer.

3. Joints

   a. Rubber Gasket Joints: Rubber gasket joints shall conform to ASTM C 443 or ASTM C 1628-06 with the following additions and exceptions.
      i. Replace ASTM C 1628-06 5.1.1 with: Circular Cross-Section or "O-Ring" Gaskets for standard use shall meet Class A requirements. Non-Circular Cross-Section or "Profile" Gaskets for standard use shall meet Class E requirements.
      ii. Replace ASTM C 1628-06 9.4 with: The manufacturer shall conduct concurrently the hydrostatic test described in 9.2 and the structural test described in 9.3. If proven watertight under these combined conditions, hairline cracks that do not leak shall not be cause for rejection. A vacuum of the American Concrete Pipe Association, may be used in lieu of the hydrostatic test referenced above.
      iii. Joint design details shall be submitted for approval together with design data and test results verifying the adequacy of the joint design.
   b. Preformed Flexible Joint Sealant: This sealant shall be either rope form or flat tape form

conforming to ASTM C 990. Primer, if recommended by the manufacturer, shall be applied within the manufacturers' time requirements on all bell and spigot joint surfaces. Joint shall be thoroughly sealed and watertight.

B. Corrugated Metal Pipe (CMP): Pipe, coupling bands, and end section conform to the following requirements:

1. Material

a.	Aluminized Steel Type 2	AASHTO M274, ASTM A 929
b.	Polymer-Coated Steel	AASHTO M246, ASTM A 742
c.	Aluminum Alloy	AASHTO M197, ASTM B 744

2. Pipe

a. Steel (Aluminized Steel, Type 2, CSP and Spiral Rib) AASHTO M36, ASTM A 760
b. Steel (Polymer-Coated, GSP, Spiral Rib, Smooth Interior CSP) AASHTO M36, AASHTO M245, ASTM A 745
c. Aluminum (CMP, Spiral Rib) AASHTO M196, ASTM A 788

Minimum wall thickness of the pipe shall be as follows:

Circular Culvert Pipe (2-2/3" x 1/2" Corrugations)					
Under Roadways or In Street Right-of-Ways		**Under Railroads**		**Not Under Roadways**	
Diameter	**Minimum Thickness**	**Diameter**	**Minimum Thickness**	**Diameter**	**Minimum Thickness**
12"-21"	.064"	12"-18"	.079"	12"-30"	.064"
24"-30"	.079"	21"-24"	.109"	36"-54"	.079"
36"-54"	.109"	30"-36"	.138"	60"-84"	.109"
60"-72"	.138"	42"-84"	.168"		
84"	.168"				

Circular Culvert Pipe (3" x 1" and 5" x 1" Corrugations)			
Under Roadways or In Street Right-of-Ways		**Not Under Roadways**	
Diameter	Minimum Thickness	Diameter	Minimum Thickness
36" – 54"	.079"	36" – 54"	.064"
60" – 84"	.109"	60" – 84"	.079"

Circular Culvert Pipe (3/4" x 3/4" x 7-1/2" Spiral Rib)			
Under Roadways or In Street Right-of-Ways		**Not Under Roadways**	
Diameter	Minimum Thickness	Diameter	Minimum Thickness
12" – 24"	.064"	12" – 42"	.064"
30" – 42"	.079"	48" – 60"	.079"
48" – 66"	.109"	66" – 84"	.109"
72" – 84"	.138"		

Arch Culvert Pipe (2-2/3" x 1/2" Corrugations)			
Under Roadways or In Street Right-of-Ways		**Not Under Roadways**	
Equivalent Diameter	Minimum Thickness	Span*	Rise*
15"	.064"	17"	13"
18"	.064"	21"	15"
21"	.064"	24"	18"
24"	.079"	28"	20"
30"	.079"	35"	24"
36"	.109"	42"	29"
42"	.109"	49"	33"
48"	.109"	57"	38"
54"	.109"	64"	43"
60"	.138"	71"	47"

* Subject to manufacturing tolerances.

Arch Culvert Pipe (3" x 1" Corrugations)			
Equivalent Diameter	**Minimum Thickness**	**Span***	**Rise***
36"	.064"	40"	31"
42"	.064"	46"	36"
48"	.064"	53"	41"
54"	.079"	60"	46"
60"	.079"	66"	51"
66"	.079"	73"	55"
72"	.079"	81"	59"
78"	.109"	87"	63"
84"	.109"	95"	67"
90"	.109"	103"	71"

* Subject to manufacturing tolerances.

Arch Culvert Pipe (3/4" x 3/4" x 7-1/2" Spiral Rib)			
Equivalent Diameter	**Minimum Thickness**	**Span***	**Rise***
18"	.064"	20"	16"
21"	.064"	23"	19"
24"	.064"	27"	21"
30"	.079"	33"	26"
36"	.079"	40"	31"
42"	.079"	46"	36"
48"	.109"	53"	41"
54"	.109"	60"	46"
60"	.109"	66"	51"
66"	.109"	73"	55"

* Subject to manufacturing tolerances.

3. Joints: Joints shall have a gasket and may be either bell and spigot joints or made with external coupling bands. The bands shall be drawn and secured on the pipe by connecting devices as furnished by the manufacturer. Pipe ends for annular corrugation shall be identical to the rest of the pipe barrel (plain ends), or in the case of helical pipe, the pipe ends at the joint shall be reformed to an annular corrugation and flange (reformed end). Gaskets shall be furnished in accordance with the Plans and Special Provisions. Coupling bands shall be reviewed and approved by the Engineer prior to installation.

C. Structural Plate Pipe and Pipe Arches: Structural plate and galvanizing shall conform to the requirements of ASTM A 761. Bolts, nuts, and washers for reconnecting plates shall be galvanized in accordance with ASTM A 153 and meet manufacturer's recommendations.

D. High Density Polyethylene (HDPE) Pipe

1. Material: Pipe manufactured for this specification shall comply with and be certified to meet the requirements for test methods, dimensions and markings found in ASTM F 2306 and AASHTO M-294, current additions. Pipe and blow molded fittings shall be made from PE compounds which conform to the requirements of cell class 435400C in the latest version of ASTM D3350.

2. Pipe Sizes: Nominal sizes for this specification include 12-60 inch diameters designated in AASHTO M294 and ASTM F 2306 as full circular cross section with an outer corrugated pipe wall and essentially smooth inner wall (waterway). Pipe corrugations shall be annular.

3. Joints: Joints shall have a gasket and may be either bell and spigot joints or made with external coupling bands. The fittings and couplings bands shall be fabricated from the same material as the pipe conforming to AASHTO M294. The coupling bands shall cover at least two full corrugations of each section of pipe and shall prevent infiltration of soil into the pipe. Gaskets shall be furnished in accordance with the Plans and Special Provisions. Coupling bands shall be reviewed and approved by the Engineer prior to installation.

4. Certification: All high-density polyethylene (HDPE) pipe used for culvert and storm sewer applications shall conform to the requirements of AASHTO M294 and ASTM F 2306, current edition. Pipe shall be provided only by manufacturers that are certified through the National Transportation Product Evaluation Program (NTPEP) Third Party Certification program.

5. Pipe Usage: High density polyethylene pipe (HDPE) may not be used for crossroad applications of collector roadways or higher unless approved by the Engineer. If approved by the engineer, HDPE in accordance with ASTM F2648, latest version, may be used in lieu of ASTM F2306 and AASHTO M294 in drainage applications that are designated as private.

E. Dual Walled Polypropylene Pipe

1. For 12-inch to 60-inch pipe, polypropylene pipe shall have a double wall with a smooth interior and annular exterior corrugations and conform to ASTM F2881 and AASHTO M330. The pipe shall not be perforated unless otherwise specified.

2. For 12-inch to 60-inch pipe, pipe shall be joined with a gasketed integral bell and spigot joint meeting the requirements of ASTM F2881.

3. Coupling bands shall cover at least two full corrugations on each section of pipe and shall prevent the infiltration of soil into the pipe.

4. Certification: All polypropylene (PP) pipe used for culvert and storm sewer applications shall be provided only by manufacturers that are certified through the National Transportation Product Evaluation Program (NTPEP) Third Party Certification program.

F. Dual and Triple Walled Polypropylene Pipe

1. For 12-inch to 30-inch pipe, polypropylene pipe shall have a double wall with a smooth interior and annular exterior corrugations and conform to ASTM F2881 and AASHTO M330 Type S. For 36-inch and larger pipe sizes, polypropylene pipe shall have a triple wall with smooth interior and exterior surfaces with inner corrugations and conform to ASTM F 2764 and AASHTO M330 Type D. The pipe shall not be perforated unless otherwise specified.

2. For 12-inch to 30-inch pipe, pipe shall be joined with a gasketed integral bell and spigot joint meeting the requirements of ASTM F2881. For 36-inch and larger pipe, pipe shall be joined with a gasketed integral bell and spigot joint meeting the requirements of ASTM F2764.

3. Coupling bands shall cover at least two full corrugations on each section of pipe and shall prevent the infiltration of soil into the pipe.

4. Certification: All polypropylene (PP) pipe used for culvert and storm sewer applications shall be provided only by manufacturers that are certified through the National Transportation Product Evaluation Program (NTPEP) Third Party Certification program.

G. Granular Bedding Material: Refer to Section 2100 Clearing and Site Preparation.

H. Flowable Backfill (CLSM): Refer to Section 2100 Clearing and Site Preparation.

2602.3 Construction

A. Trench Excavation: Refer to Section 2100 Clearing and Site Preparation.

1. Unclassified Excavation: Refer to Section 2100 Clearing and Site Preparation.

2. Rock Excavation: Refer to Section 2100 Clearing and Site Preparation.

3. Earth Excavation: Refer to Section 2100 Clearing and Site Preparation.

4. De-watering: Refer to Section 2100 Clearing and Site Preparation.

5. Cribbing and Sheeting: Refer to Section 2100 Clearing and Site Preparation.

6. Unstable Foundation: Refer to Section 2100 Clearing and Site Preparation.

7. Protection of Property: The Contractor shall satisfactorily shore, support, and protect any and all structures and all pipes, sewers, drains, conduits, and other facilities, and shall be responsible for any damage resulting thereto. The Contractor shall not be entitled to any damages or extra pay on account of any postponement, interference, or delay caused by any such structures and facilities being on the line of work, whether or not they are shown on the Plans; specifically, but not limited to, damage due to delay in utility relocation.

B. Laying and Jointing

1. Handling and Protection: All pipe shall be protected during installation against shock and free fall, and be installed without cracking, chipping, breaking, bending, or damage to coating materials. Damaged pipe materials shall be replaced with new materials.

2. Grade Control: Maximum deviation from indicated alignment of any pipe after installation and backfilling shall not be greater than 0.1 foot. All pipe shall have a continuous slope free from depressions that will not drain. The Contractor shall establish such grade control devices as are necessary to maintain the above tolerances.

3. Laying: The laying of pipe in finished trenches shall commence at the lowest point, and pipe shall be installed with the bell end forward or upgrade. All pipe shall be laid with ends abutting and true to line and grade. Pipe laid shall be carefully centered to form a sewer with a uniform invert.

4. Bedding: Bedding shall be rodded, spaded, and consolidated as necessary to provide firm uniform support for the pipe, and not subject pipe to settlement or displacement.

5. Jointing: Preparatory to making filled, bonded, and watertight sealed pipe joints, all surfaces of the portions of the pipe to be jointed shall be clean and dry. Lubricants, primers, adhesives, and other substances that are used shall be compatible with the jointing material recommended or specified.

   Other than for trimming sewer pipe to be flush with the inside walls of storm sewer structures, no pipes may be trimmed unless ordered by the Engineer.

   Trenches shall be kept water-free and as dry as possible during bedding, laying, and jointing, and for as long a period as required to protect the pipe joints and concrete in structures.

   As soon as possible after the joint is made, sufficient bedding material shall be placed alongside each side of the pipe to offset conditions that might tend to move the pipe off line and grade.

   a. Concrete Pipe
      i. Plastic Joint Sealant: Plastic joint sealant shall be applied to the tongue and spigot prior to its insertion into the bell or groove. A sufficient amount of sealant shall be

used to fill the annular joint space with some excess. Wipe the outside surface of the joint with additional material to assure a complete seal.

ii. Flexible Gaskets: Flat gaskets may be cemented to the pipe tongue or spigot. O-ring gaskets shall be recessed in a groove on the pipe tongue or spigot and confined by the bell or groove after the joint is completed. Roll-on gaskets shall be placed around the tongue or spigot and rolled into position as the joint is assembled. Flat gaskets and O-ring gaskets shall be lubricated as recommended by the manufacturer.

a) Flat gasket: Flat flexible gaskets shall conform to ASTM C 443. If there is no recess provided for the gasket, the surface of the tongue shall be cleaned and rubber adhesive applied. Using quick-drying adhesive, gaskets may be applied ahead of the laying operation or in the plant.

b) O-ring gasket: O-ring or roll-on flexible gaskets shall conform to ASTM C 361, Section 4.10. The entire surface of the bell that comes in contact with the rubber gasket shall be well lubricated with a soap lubricant. The entire gasket shall be greased with soap. Only the soap lubricant supplied by the pipe manufacturer shall be used. Adhesive type cements shall not be used.

b. Corrugated Metal Pipe. Corrugated metal pipe joints shall have a gasket and may be either bell and spigot joints or made with external coupling bands. The bands shall be drawn and secured on the pipe by connecting devices as furnished by the manufacturer. Pipe ends for annular corrugation shall be identical to the rest of the pipe barrel (plain ends), or in the case of helical pipe, the pipe ends at the joint shall be reformed to an annular corrugation and flange (reformed end). Gaskets shall be furnished in accordance with the Plans and Special Provisions. Coupling bands shall be reviewed and approved by the Engineer prior to installation.

c. HDPE Pipe: HDPE pipe shall be assembled, installed, and backfilled in accordance with the manufacturer's instructions. Joints shall have a gasket and may be either bell and spigot joints or made with external coupling bands. The fittings and couplings bands shall be fabricated from the same material as the pipe conforming to AASHTO M294. The coupling bands shall cover at least two full corrugations of each section of pipe and shall prevent infiltration of soil into the pipe. Gaskets shall be furnished in accordance with the Plans and Special Provisions. Coupling bands shall be reviewed and approved by the Engineer prior to installation.

During construction of the project in areas subjected to heavy construction equipment traffic, pipe sizes 12" - 42" shall have a minimum cover of 3 feet, and pipe sizes 48"- 120" shall have a minimum cover of 4 feet.

d. Structure Connections: Pipes connected to structures shall be cut parallel with the inside face of the structure for structures having plane walls and parallel with the spring line of the pipe for structures having curved walls. Projection of the pipe beyond the inside face shall not exceed 1 inch (measured at the springline for structures having curved walls).

C. Backfill of Trenches

1. General: Refer to Section 2100 Clearing and Site Preparation.

SECTION 2603 BORING AND JACKING

2603.1 Scope

This section governs the furnishing of all labor, materials and equipment for the construction of steel casings, complete

with bulkheads and sand fill, by boring and/or jacking at the locations and to the lines and grades indicated on the Plans, or where constructed at the Contractor's option, when approved, to bypass obstructions without open cutting.

2603.2 Materials

A. Steel Casing

1. Steel casing for bored or jacked construction shall conform to ASTM A 139.

2. Steel shall be grade B under railroads and grade A for all other uses.

3. Minimum wall thickness for steel casing shall be in accordance with the following table:

Diameter of Casing	Under Railroads	All Other Uses
24"	0.406"	0.281"
26"	0.438"	0.281"
28"	0.469"	0.312"
32"	0.500"	0.312"
34"	0.500"	0.312"
36"	0.500"	0.344"

4. Casing joints shall be welded by a certified welder in accordance with ANSI/AWWA C206.

B. End Seals: End seals shall be manufactured end seals, concrete plugs with allowances for water flow, or brick shall be in accordance with ASTM C 32, Grade SS or SM and mortar in accordance with ASTM C 270.

C. Sand Fill: Sand fill shall comply with ASTM C 33 or MCIB Section 4, Fine Aggregate. Moisture content of the sand shall not exceed 0.5%.

2603.3 Construction Details

A. Boring and Jacking

1. Prior to starting work, complete details of the methods and the liner material to be used shall be submitted to the Engineer for approval.

2. The maximum allowable deviation from indicated alignment and grade shall be as follows except when altered by the Plans or Special Provisions:

   a. Alignment 1.0%
   b. Grade 1.0%

B. Casing Installation

1. The steel casing shall be advanced in a continuous operation without interruption. Sections of the casing pipe shall be welded together to form a continuous conduit capable of resisting all stresses including jacking stresses. The casing in its final position shall be within alignment and grade tolerances specified in Section 2603.3.A.2. There shall be no space between the earth and the outside of the casing. Any voids which do occur shall be filled by pressure grouting.

2. Boring operations shall be performed by experienced crews using a rotary type boring machine designed especially for this purpose. Boring shall be performed in a manner to prevent disturbing the overlying and adjacent materials.

3. Jacking

   a. Jacking frame, guides, blocking, head, and reaction devices shall be arranged to apply uniform pressure about the casing circumference without damage to the casing material, and to maintain alignment within specified tolerances.
   b. Jacking reaction device shall provide adequate resistance to withstand 200 percent of the maximum jacking pressure.
   c. Provide jacks of adequate number and size for the required jacking pressure; but not less than two jacks.
   d. Maintain jacking pit and pipe installation in such condition that drainage does not accumulate. Control and disposition of surface and subsurface water at the site of jacking operations shall be the Contractor's responsibility.
   e. Excavation at the heading shall not be extended more than 1 inch outside the top and sides (upper 300-degree sector) of the casing and shall be true to grade at the invert (lower 60-degree sector).
   f. Once jacking begins, it shall proceed without interruption until installation of the entire length of the jacked casing is complete.

4. Excavation in Jacked Casings: Perform excavation within jacked casings by hand or machine methods as necessary to remove the materials encountered without disturbing the overlying material. The jacked casing shall be advanced a sufficient distance ahead of the excavation face and/or shield used as necessary to protect the workman and the work, and to prevent the uncontrolled entry of unstable materials into the casing.

5. Unstable Materials: If materials are encountered during casing installation that cannot be excavated safely or without creating voids around the exterior of the casing, the Contractor shall discontinue casing installation and stabilize such materials by dewatering, chemical soil stabilization, grouting, or other methods, and/or modify equipment and procedures as necessary to complete the casing installation.

C. Sewer Pipe Installation

1. Pipe shall be placed inside the casing to the indicated line and grade by the use of wood skids or other equivalent methods. The wood shall be pressure-treated with a preservative in accordance with ASTM D 1760. Cut surfaces shall be given 2 heavy brush coats of the same preservative. The wood skids shall be securely fastened to the sewer pipe with steel straps.

2. End seals shall be constructed after the sewer pipe is installed and approved.

3. The annular space between the casing and sewer pipe shall be filled with sand blown in so that all space is filled without disturbing the alignment and grade of the sewer pipe. Flowable Backfill (CLSM) meeting Section 2102.2.E, may be substituted in lieu of sand fill. Alternative methods may be submitted for approval by the Engineer.

SECTION 2604 STRUCTURES

2604.1 Scope

This section governs the furnishing of all labor, materials and equipment for the performance of all work necessary for construction of cast-in-place and precast concrete structures for inlets, manholes, junction boxes, box culverts, headwalls, and incidental structures.

Masonry or brick structures shall not be allowed under these Specifications.

2604.2 Materials

A. Concrete Mixes: Concrete shall be MCIB Mix Number A 558-1-2-0.421 or KCMMB 4K, unless otherwise specified.

B. Concrete Materials

1. For KCMMB mixes, concrete shall be an approved mix with admixtures that are approved for use in that mix design.

2. For MCIB mixes:

    a. Air-entraining admixtures shall provide an air content within the range of 4 1/2 to 7 1/2 percent by volume as measured by the pressure method (ASTM C 231). The air entraining admixtures shall meet the requirements of ASTM C 260.
    b. Portland Cement: Portland cement shall conform to ASTM C 150 Type I. Where high early strength is desired, Type III can be used.
    c. Fine Aggregate: Fine aggregate shall be clean, natural sand meeting the requirements of ASTM C 33. Grading shall be within the limits as set forth by MCIB.
    d. Coarse Aggregate: Coarse aggregate shall be limestone meeting the requirements of ASTM C 33. The sum total of all deleterious material shall not exceed the requirements of ASTM C 33.

3. Water: Water shall be clean and free from deleterious substances. Only potable water will be acceptable without testing.

C. Reinforcing Steel: Reinforcing bars shall conform to ASTM A 615 or AASHTO M 31, Grade 60. Welded steel wire fabric shall conform to ASTM A 1064 or AASHTO M 55.

D. Precast Concrete Structures

1. Manholes: Precast manholes shall conform to ASTM C 478.

2. End Sections for Concrete Pipe: Shall be flared end sections of the pipe manufacturer's standard design, and shall meet all applicable requirements of ASTM C 76 for Class II or higher classes of pipe.

3. Rectangular Structures: Shall conform to the inside dimension indicated on the Plans and be designed for the following loads:

    a. HS-20 live load for all structures in/or under pavement, shoulders, driveways, and other traffic areas.
    b. 2,000-lb wheel live load for curb opening inlets and junction boxes in non-traffic areas.
    c. 50 pcf equivalent fluid pressure for soil pressure on vertical walls.
    d. 120 pcf for unit weight of soil cover on top slabs.

4. Joints: Joints between concrete structures shall be filled with plastic joint compound or preformed plastic compound as stated herein.

   a. Barrel Sections: Minimum cross sectional area of preformed compound between concrete barrel sections shall be 1 inch square or 1.25 inches diameter. Minimum cross-sectional area of the preformed compound between the concrete adjustment ring and cone barrel section shall be two beads of either 1 inch square or 1.25 inches in diameter.

   b. Manhole Adjustment Rings: Rings shall be constructed of concrete, HDPE, or recycled rubber.

      If HDPE adjustment rings are used, they shall be injection molded-recycled HDPE - as manufactured by LADTECH, Inc. or approved equal. They shall be bolted to the structure top section and otherwise installed as per manufacture's recommendations.

      If recycled rubber adjustment rings are used, they shall consist of no less than 80%, by weight, recycled rubber and no less than 10% by volume shredded fiber as manufactured by GNR Technologies or approved equal. They shall be installed as per manufacturer's recommendations.

      The top and bottom of all adjustment rings shall be sealed using a mastic filler meeting the requirements of 2503.D.6 or an epoxy paste. The epoxy paste shall be a two component, moisture insensitive, containing no solvents, and capable of bonding with all materials it is to be used on, like Epoxytec Micor C.P.P or approved equal. Minimum cross-sectional area of preformed compound between concrete adjustment rings shall be two beads of either 1 inch square or 1.25 inches in diameter.

   c. Manhole Ring and Covers: Minimum cross-sectional area of preformed compound between the concrete adjustment ring and the manhole casting shall be two beads of either 1 inch square or 1.25 inches in diameter.

   d. External Manhole Chimney Frame Seal: External frame seal shall consist of a flexible rubber sleeve, interlocking adjustment extension(s), and stainless steel compression bands. The flexible rubber sleeve and extension shall be extruded or molded from a high grade rubber compound conforming to the applicable requirements of ASTM C 923 with a minimum tensile strength of 1500 psi and minimum elongation at break of 350%. At a minimum, the compression bands shall be 16-gauge stainless steel conforming to ASTM A 240, Type 304, with a minimum width of one inch. Screws, nuts, and bolts shall be stainless steel conforming to ASTM F 593 and 594, Type 304. The compression bands shall have the capacity to tighten with enough pressure to make a watertight seal around the rubber chimney sleeve.

E. Air Entrainment: All concrete shall be air entrained. Minimum strength requirements shall be as specified in Section 2604.2.A. Concrete Mixes.

F. Manhole Castings

1. Rings and Covers: Castings shall be gray iron conforming to ASTM A 48, Class 35B. Castings of rings and covers shall be of the shape, dimension, minimum weight, and type as indicated on Plans or Standard Drawings and be free from manufacturing defects. All curb inlet castings shall have cam locks or approved equal. If requested by special order, castings shall be cleaned and painted with one coat of tar prior to delivery. Bearing surfaces between all rings and covers for installation in all areas

shall be machined to provide even seating and interchangeability of like pieces.

All manhole rings and covers placed in paved areas shall be rated for H20 traffic. Cam lock covers or similar shall not be placed in roadway pavement unless shown on the Plans or directed by the Engineer. All covers shall have provisions for opening, such as concealed pick holes.

2. Steps: All steps shall comply with Section 2509.3.G.2.b. Cast iron steps shall not be used.

G. Steel End Sections: Steel end sections shall be fabricated from aluminized base metal as specified in Section 2602, and shall be flared end sections of the metal pipe manufacturer's standard design. End sections shall be furnished with a steel toe plate. Bituminous coating is not required.

H. Toe Walls: Flared end sections for concrete and steel pipe shall be set on a concrete toe wall centered on the end of the section. Toe walls shall be 8 inches thick by 24 inches deep by the width of the end section.

2604.3 Construction

A. Concrete Structures: Concrete construction shall conform to the current ACI 301 Specifications for Structural Concrete.

1. Precast Structures: The Contractor may, at his option, construct precast concrete inlets, junction boxes, and box culverts, in lieu of the cast-in-place structures indicated on the Plans; except that all concrete base slabs for pre-cast inlets, manholes, and junction boxes may be cast-in-place. Solid concrete brick or block shall be used to block inlets and similar structures to grade during placement of base slab concrete.

   Precast concrete box culvert sections shall be installed on a 4-inch leveling course of untreated compacted aggregate conforming to Section 2200 Paving. Leveling courses shall extend 1 foot past the line of the box section, and be finished to a true plane surface to provide uniform bearing for the precast section.

   Any adjustments required for precast structures to meet field conditions shall be at the cost of the Contractor.

2. Finishing: Exposed edges of all slabs, walls, and other concrete structures shall be beveled 3/4" or edged with a 1-1/4" radial tool.

   a. Formed Surfaces: Immediately following removal of the forms, fins and irregular projections shall be removed. Form tie connections, holes, honeycomb spots, and other defects shall be chipped to ensure the voided area is exposed, and shall be chipped back to solid material. These areas shall be thoroughly cleaned, saturated with water, and painted with a grout approved by the Engineer. The repaired surfaces shall be cured in accordance with these specifications.
   b. Exposed Slabs: Finish for exposed slabs shall be wood float texture. Exposed edges shall be beveled or edged with a radial tool.

3. Form Removal: Forms shall remain in place until the concrete has attained sufficient strength to support loads imposed by backfilling, construction, and traffic. Within 24 hours of form removal, small holes and pockmarks of exposed walls shall be filled with Portland cement grout and rubbed smooth. Concrete voids and honeycombs shall be chipped open with a light hammer to expose weak areas for

inspection. At the direction of the Engineer, expansive repair grout shall be used for partial reconstruction of otherwise sound structures.

a. Walls: Forms shall remain in place for a minimum of 5 days or until the concrete reaches a minimum strength of 2000 psi.
b. Slabs: Form shall remain in place for a minimum of 7 days or until the concrete reaches a minimum strength of 3000 psi.

4. Manhole Riser Adjustments: Manhole rings and covers shall be adjusted to match the slope and height, or grade, of pavements. In no case shall the surface pitch of the manhole ring and cover mismatch the pavement slope by more than 1/2 inch. The difference in height between the top of manhole cover and the top of precast cone shall not exceed 24 inches.

   In lieu of replacing concrete adjustment rings that are properly seated and structurally sound but have a small fracture, an external rubber chimney may be fitted to secure a watertight seal between the casting (manhole ring and cover) and the concrete cone barrel section.

B. Invert Channels: Form concrete invert channels in manholes, inlets, and junction boxes to make changes in direction of flow with smooth curves of as large a radius as permitted by the inside dimension of the structure.

Grade changes and transitions shall be smooth and uniform, and all parts of the invert channel and adjacent floor shall slope to drain. Channel bottom shall be finished smooth without roughness or irregularity. Invert channels for precast concrete structures may be cast integrally with the structure base slabs at the Contractor's option.

C. Excavation and Backfill: Refer to Section 2100 "Clearing and Site Preparation".

SECTION 2605 OPEN CHANNELS

2605.1 Scope

This section governs the furnishing of all labor, materials and equipment for the construction of open channel lining at the location, and to the lines, grades, and dimensions indicated on the Plans. Grading shall have been previously completed in accordance with Section 2100 Grading and Site Preparation.

2605.2 Materials

A. Concrete Materials: Concrete shall be in accordance with 2604.2.B, unless otherwise specified. Reinforcing steel shall conform to ASTM A 615 or AASHTO M 31, Grade 60. Welded steel wire fabric shall conform to ASTM A 1064 or AASHTO M 55.

B. Stone: Stone for riprap, and gabion linings shall consist of quarried rock and be sound, durable, and angular in shape. No more than 10 percent shall have an elongation greater than 3:1, and no stone shall have an elongation greater than 4: 1. Material shall be free from cracks, seams, or other defects. Shale and stone with shale seams are not acceptable.

1. The minimum unit weight of the stone shall be 155 pounds per cubic foot as computed by multiplying the specific gravity times 62.4 pounds per cubic foot.

2. Not more than 10 percent of the stone shall exhibit splitting, crumbling, or spalling when subject to 5

cycles of the sodium sulfate soundness test in accordance with ASTM C 88.

3. Riprap: Riprap shall have a minimum thickness of 15 inches, or 1.5 times as thick as the larger stones, whichever is greater.

The gradation for RipRap (Light Stone) shall be as follows:

Weight of Stone In Lbs.	Percent Passing by Weight
250	100 (minimum)
100	50 (maximum)
75	70 (maximum)
5	10 (maximum)

The gradation for RipRap (Heavy Stone) shall be as follows:

Weight of Stone In Lbs.	Percent Passing by Weight
1,000	100 (minimum)
500	50 (maximum)
75	10 (maximum)

The Contractor shall provide certification that the material meets the specified gradations.

4. Gabion Fill Stone: Stone shall be of the following gradations:

U.S. Standard Square Mesh Sieve	Percent Passing by Weight
10”	100
8”	85 - 100
6”	0 - 15
4”	0- 10
3”	0

Stone shall be graded within the above limits as required to provide a unit weight in-place of 100 pounds per cubic foot or greater.

The Contractor shall provide certification that the material meets the specified gradations.

C. Filter Blanket: Filter blanket may be either of the following types at the Contractor’s option:

1. Granular Filter: Granular filter material shall consist of sound, durable rock particles conforming to the following gradation:

Sieve Size	Cumulative Percent Passing By Weight
1”	100
1/2”	70 - 100
No. 4	50 - 85
No. 10	35 - 70
No. 40	20 - 50
No. 100	15 - 40

The Contractor shall provide certification that the material meets the specified gradations.

2. Filter Fabric: Filter fabric shall consist of woven or nonwoven fabric. The synthetic fiber of either the woven or nonwoven fabric shall consist of polypropylene, nylon, or polyester filaments. The percent open area shall be not less than 4 percent nor more than 10 percent. The cloth shall provide an Equivalent Opening Size (EOS) no finer than the U.S. Standard Sieve No. 100. In addition, filter fabric shall meet the following physical requirements:

   a. Tensile Strength: Minimum grab tensile strength, both warpwise and fillingwise, shall be 200 pounds when tested in accordance with ASTM D 5034, using a 4-inch by 6-inch specimen and a jaw speed of 12 inches per minute.
   b. Elongation: Grab elongation shall be not less than 15 percent nor more than 60 percent, both warpwise and fillingwise, when tested in accordance with ASTM D 5034.
   c. Tear Strength: Minimum trapezoid tear strength shall be 100 pounds, both warpwise and fillingwise. Method of test for woven fabrics shall be in accordance with ASTM D 1117.
   d. Bursting Strength: Minimum bursting strength shall be 400 psi when tested in accordance with ASTM D 3887.
   e. Seam Strength: Woven fabric shall have a minimum seam-breaking strength of 180 pounds when tested in accordance with ASTM D 1683, using a jaw speed of 12 inches per minute.
   f. Width: Filter fabric shall be furnished in widths of not less than 6 feet.

D. Gabion Baskets: Baskets shall be of the dimensions indicated on the drawings and be fabricated using hexagonal triple-twist wire mesh.

1. Wire: Wire shall be galvanized steel having a minimum tensile strength of 60,000 psi, and shall be zinc coated in accordance with ASTM A 641 Class 3.

2. Wire Mesh: Maximum dimension of the mesh opening shall be 4-1/2 inches or less, and the maximum area of the mesh opening shall not exceed 12 square inches. Wire shall be 0.120-inch (minimum) diameter.

3. Selvedge Wire: Selvedge wire shall be 0.1535-inch (minimum) diameter. All perimeter edges of the mesh forming the gabion shall be securely selvedged so that joints formed by tying the selvedges have a strength equal to or greater than the body of the basket.

4. Lacing and Stay Wire: Wire shall be 0.0866-inch diameter or larger. Other connection methods, such as stainless steel clips, may be substituted with approval of the Engineer.

5. Diaphragms: Gabions shall be divided into cells not greater than 4 feet in width by wire mesh diaphragms. Diaphragms shall be factory secured to the base of the basket by continuous spiral wire.

6. PVC (Polyvinyl Chloride) Coating: Where specified in the Plans, all wire used in the fabrication of the baskets and in the wiring operations during construction shall, after zinc coating, have an extruded coating of PVC. The coating shall be gray in color ranging between series 26187 and 26293 or between series 26373 and 26375, semi-gloss, as per Federal Standard 595B. The PVC coating shall be a nominal thickness of 0.02165 inches and shall nowhere be less than 0.015 inches in thickness. The coating shall be resistant to the destructive effects of immersion in acidic, salt or polluted water, exposure to ultraviolet light, and abrasion and shall retain these characteristics after a period of not less than 3,000 hours under test in accordance with ASTM G 23.

E. Sod: Sod shall conform to the requirements of Section 2400 Seeding, Sodding and Overseeding.

F. Seed: Seeding shall conform to the requirements of Section 2400 Seeding, Sodding and Overseeding.

2605.3 Construction

A. Foundation Preparation: After completion of grading in accordance with Section 2100, the area to receive channel lining shall be trimmed and dressed to conform to the cross sections indicated on the Plans within a tolerance of plus or minus 1 inch from the theoretical slope lines and grades. All deleterious materials shall be removed from the foundation area.

B. Concrete Lining

1. Preparation: Subgrade shall be moistened by sprinkling. Forms shall be securely staked, braced, and set to line and grade. Reinforcement and tie bars shall be held in position by bar chairs, concrete brick, or other approved devices.

2. Placing and Finishing: Place, consolidate, and strike off concrete to the thickness indicated on the drawings. Concrete shall be tamped or vibrated to eliminate all voids and bring sufficient mortar to the top for finishing. Surface finish shall be a wood-float finish. Round all edges and joints with a 1/4 inch radius edging tool, except contraction joints may be sawed to a depth of 30 percent of the thickness of the concrete lining after concrete has hardened but before uncontrolled cracking occurs. Apply curing membrane as specified in Section 2000 “Paving”.

C. Filter Blanket

1. Granular Filter: Place granular filter to its full thickness in a single operation. Construction methods shall be such that the material is placed without segregation. Compaction of granular filter material is not required.

2. Filter Fabric: Place filter fabric with its long dimension horizontal and lay free of tension, stress, folds, wrinkles, or creases.

    a. Place to provide 18 inches minimum overlap at each joint and anchor to prevent dislocation during construction of overlaying material.
    b. Fabric shall not be left exposed more than two weeks prior to placement of overlaying material. Tracked or wheeled equipment or vehicles shall not be operated on the fabric.

D. Riprap Placement: Riprap shall be placed on the prepared foundation in a manner which will provide a reasonably well-graded mass of stone with the minimum practicable percentage of voids. The entire mass of stone shall be placed so as to be in conformance with the lines, grades, and thicknesses indicated. A filter blanket of filter fabric conforming to Section 2605.2.C.2 shall be constructed under all riprap. Riprap shall be placed to full-course thickness in one operation and in such a manner as to avoid displacing the fabric. The Contractor shall place the riprap in such a way as to not tear, puncture, or shift the fabric. Riprap shall not be dropped more than 3 feet when being placed directly on the fabric. Tears or rips in the fabric shall be repaired with fabric lapped a minimum of 12 inches in all directions.

1. Placing: Placing of riprap in layers, or by dumping into chutes, or by similar methods likely to cause segregation will not be permitted.

2. Distributing: The larger stones shall be well distributed and the entire mass of stone shall conform to the specified gradation. All material shall be so placed and distributed that there will be no objectionable accumulations of either the larger or smaller sizes of stone.

3. Hand Placing: It is the intent of these specifications to produce a fairly compact riprap protection in which all sizes of material are placed in their proper proportions. Hand placing or rearranging of individual stones by mechanical equipment may be required to the extent necessary to secure the specified results.

E. Gabion Baskets

1. Assembly: Assemble each gabion unit by binding all vertical edges together with a continuous piece of connecting wire stitched around the vertical edge with coils spaced at 3 inches or less. Set empty units to line and grade and join units by stitching with connecting wire along adjoining edges. Install and securely fasten internal tie wires in each cell if necessary to retain the shape of the cell during filling operations.

2. Filling: Fill gabion cells with stone carefully by hand or machine to provide a minimum of voids and avoid bulges and distortions of the gabion. After filling, secure the lid to the sides, ends, and diaphragm by stitching with connecting wire.

3. Filter Fabric/Gabion Unit Placement: A filter blanket of filter fabric conforming to Section 2605.2.C.2 shall be constructed under all Gabion Baskets. The Contractor shall place the gabions in such a way as to avoid tearing, puncturing, or shifting the fabric. Tears or rips in the fabric shall be repaired with fabric lapped a minimum of 12 inches in all directions.

F. Sod: Sod shall be installed as specified in Section 2400 Seeding, Sodding and Overseeding, except all sod placed in drainage channels or ditches, including both the side slopes and bottom, shall be anchored in accordance with 2204.3.D.

SECTION 2606 MEASUREMENT AND PAYMENT

2606.1 Measurement

The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.

A. Pipe: By the linear foot of each size and type. Measurement will be to the nearest 0.1 foot for each line between structures, and made to the inside face of the connecting structure. Precast or prefabricated end sections will be excluded from the pipe measurement. Excavation, bedding, and backfill shall be included in the cost per linear foot of pipe per each size and type.

B. Prefabricated or Precast End Sections: By the number of each size and type.

C. Concrete Box Culverts: By the linear foot of each size and type. Measurement will be along the center line of the culvert between the back faces of the headwalls. Headwalls will be measured separately as “Structures”.

D. Structures: Inlets, manholes, headwalls, endwalls, curb inlets, field inlets, and other similar structures will be measured by the number of each size and type as listed in the Contract Documents.

E. Casings: Casings for pipe installation by boring and/or jacking methods will be measured by the linear foot of

each size and type.

F. Pipe Encasement: Pipe encasement will be measured by the linear foot of each size and type.

G. Concrete Channel Lining: By the square yards of surface area. Measurement will be parallel to sloping surfaces.

H. Filter Blanket: Unless otherwise stated in the Agreement, there will be no separate measurement or payment for filter blanket. All costs for such work shall be included in the price of the related item.

I. Riprap: By the square yard of surface area per each size and depth as specified on the Plans or Standard Drawings. Measurement will be parallel to sloping surfaces. The thickness of the riprap shall conform to the plan dimension. Measurement and payment of the filter fabric shall be included in the cost per square yard of the riprap.

J. Gabion Baskets: By the cubic yard on the basis of Plan dimensions.

K. Sodding: Measurement shall be per square yard. Areas that are disturbed which lie outside the construction limits, as defined by the Plans, will not be measured for payment, but shall be restored to a condition equal to or better than that existing prior to construction. For lined (riprap or concrete) channels, sod placement and/or repairs shall be incidental to the cost of placement of the lining material.

L. Seeding: Measurement shall be per square yard. Areas that are disturbed which lie outside the construction limits, as defined by the Plans, will not be measured for payment, but shall be restored to a condition equal to or better than that existing prior to construction. For lined (riprap or concrete) channels, sod placement and/or repairs shall be incidental to the cost of placement of the lining material.

2606.2 Payment

Payment will be made at the respective unit or lump sum price listed in the Contract Documents, and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the Contract Documents, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the Contract Documents. At the Engineer's option, partial payment may be made for any item listed in the Contract Documents, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved progress schedule.

END OF SECTION

SECTION 2700 – STRUCTURES

CITY OF LEE'S SUMMIT, MISSOURI
STANDARD SPECIFICATIONS

The City of Lee's Summit hereby adopts Section 2700 of the Kansas City Metropolitan Chapter of APWA Construction and Material Specifications, current edition.

DIVISION II
CONSTRUCTION AND MATERIAL SPECIFICATIONS SEWERS
SECTION 2700 – STRUCTURES

APPROVED AND ADOPTED THIS 15th DAY OF FEBRUARY, 2017

KANSAS CITY METROPOLITAN CHAPTER
OF THE AMERICAN PUBLIC WORKS ASSOCIATION

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SECTION 2701 GENERAL

2701.1 Scope

This section governs the furnishing of all labor, materials, and equipment for the construction of bridges, reinforced box culverts, retaining walls, and other miscellaneous structures as shown on the Plans and in accordance with the Standard Drawings, the specifications, and the Special Provisions.

2701.2 General

The purpose of these specifications is to provide uniformity in the Metropolitan Kansas City Area for the public works structures which are designed and constructed for the many separate municipal and county jurisdictions included therein.

SECTION 2702 SPECIFICATIONS

Procedural and administrative items covered in the Contract Documents shall supersede such items covered in the specifications referenced below unless specifically noted.

2702.1 Jurisdiction in Kansas

For jurisdictions in Kansas, the current edition of the Standard Specifications for State Road and Bridge Construction, State Highway Commission of Kansas and latest version of Special Provisions shall apply. This specification is available from:

Kansas Department of Transportation
Bureau of Fiscal Services
Docking State Office Building
7th Floor
Topeka, Kansas 66612
(913) 296-3545

2702.2 Jurisdiction in Missouri

For jurisdictions in Missouri, the current edition of the Missouri Standard Specifications for Highway Construction, Missouri Highway and Transportation Commission and latest version of Job Special Provisions shall apply. This specification is available from:

Division Engineer
Surveys and Plans
Missouri Department of Transportation
P.O. Box 270
Jefferson City, Missouri 65102
(314) 751-2551

END OF SECTION

SECTION 3500 - SANITARY SEWERS

CITY OF LEE'S SUMMIT, MISSOURI
STANDARD SPECIFICATIONS

3501 MATERIALS

A. General: All materials shall conform to the latest revision of the reference standard applying to that particular material.

B. Pipe and Fittings for Sanitary Sewers

1. Allowable Materials: Pipe and fitting materials used in the construction of sanitary sewers shall be:

   a. Ductile Iron (DI) special thickness Class 50
   b. Polyvinyl Chloride (PVC)
   c. High Density Polyethylene (HDPE) (for force mains only)

2. Requirements: The pipe manufacturer shall furnish pipe of materials, joint types, sizes, and strength classes indicated and specified. The Contractor shall furnish maximum pipe lengths normally produced by the manufacturer except for fittings, closures, and appurtenances.

3. Manufacturer's Experience: The Manufacturer shall be experienced in the design, manufacture, and commercial supplying of the specified material.

4. Inspection and Testing: Inspection and testing shall be performed by the Manufacturer's quality control personnel in conformance with applicable standards.

5. Markings: Each pipe or fitting shall have the following information plainly and permanently marked by indenting in the outside surface of the pipe or painted thereon with waterproof paint:

   a. Pipe size and class or designation.
   b. Date manufactured and lot number.
   c. Manufacturer's name or trademark.
   d. For ductile iron pipe, in lieu of the above listed markings, the information may be provided on an adhesive bar code labeling system that complies with AWWA Standards. The adhesive label shall be provided on the outside surface near the bell.

6. Handling: The Manufacturer and Contractor/Developer shall use equipment and methods adequate to protect the pipe and joint elements and to prevent shock contact of adjacent units during moving or storage. Damaged sections that cause reasonable doubt as to their structural strength or water-tightness shall be rejected.

7. On-Site Inspection: All pipe and appurtenances shall be inspected by the Inspector prior to installation, and all damaged pieces, as well as any pieces not complying with

the City of Lee's Summit Standard Specifications, shall be immediately removed from the job site and replaced by pipe and appurtenances as may be acceptable to the Inspector at the expense of the Contractor/Developer.

8. Certification: Suppliers shall submit certifications with their material delivery. These certifications shall be given to the Inspector.

C. PVC Sewer Pipe and Fittings

1. Type PSM PVC Sewer Pipe and Fittings (4-inch through 15-inch diameters only): Pipe and fittings shall conform to ASTM D 3034 and F1336, except as otherwise specified herein.

   a. Material: The pipe shall be made of PVC plastic having a cell classification of 12454B or 12364B as defined in ASTM D 1784. The fittings shall be made of PVC plastic having a cell classification of 12454B or 13343B as defined in ASTM D1784.

   b. Design: Pipe shall have an integral wall bell and spigot joint and a minimum wall thickness complying with SDR 26. Fittings shall have a minimum wall thickness complying with SDR 26.

   c. Joints: Joints shall conform to ASTM D 3212. Joints shall be push-on type only with the bell-end grooved to receive a gasket. Elastomeric seals (gasket) shall have a basic polymer of synthetic rubber complying with ASTM F 477. Natural rubber gaskets shall not be accepted.

   d. Fittings:

      i. Fittings defined as wye connections suitable for assembly to 4- or 6-inch building sewers shall be bell-end with a minimum wall thickness complying with SDR 26 and shall be furnished by the pipe manufacturer.

      ii. Fittings shall be clearly marked with their SDR number. The markings shall be applied to the fittings in such a manner that they remain legible after installation and inspection has been completed.

2. PVC Pressure-Rated Pipe (SDR Series): Pipe shall conform to ASTM D 2241 except as otherwise specified herein.

   a. Material: The pipe shall be made of PVC plastic having a cell class of 12454B or 14333B, as defined in ASTM D 1784.

   b. Design: Pipe shall have an integral wall bell and spigot joint. Pipe shall have a minimum wall thickness complying with Table 2 in ASTM D 2241.

   c. Joints: Joints shall conform to ASTM D 3212 for gravity lines and ASTM D 3139 for pressure lines. Joints shall be push-on type only with the bell-end grooved to

receive a gasket. Elastomeric seals (gasket) shall have a basic polymer of synthetic rubber complying with ASTM F 477. Natural rubber gaskets shall not be accepted.

d. Fittings: Fittings shall be DI and shall conform to the requirements of Paragraph 3501.D.

3. PVC Plastic Pipe, Schedule 40: Pipe and fittings shall conform to ASTM D 1785 and ASTM D 2466, respectively, except as otherwise specified herein.

a. Material: The pipe and fittings shall be made of PVC plastic having a cell class of 12454B, as defined in ASTM D 1784.

b. Design: Pipe shall have an integral wall bell and spigot joint. Pipe shall have a minimum wall thickness complying with Table 2 in ASTM D 1785. Fittings shall have a minimum wall thickness complying with Table 1 in ASTM D 2466.

c. Joints: Joints shall conform to ASTM D 3212. Joints shall be push-on type only with the bell-end grooved to receive a gasket. Elastomeric seals (gasket) shall have a basic polymer of synthetic rubber complying with ASTM F 477. Natural rubber gaskets shall not be accepted.

d. Fittings:

i. Fittings shall be bell-end with a minimum wall thickness complying with Schedule 40 and shall be furnished by the pipe manufacturer.

ii. Fittings shall be clearly marked with their schedule number. The markings shall be applied to the fittings in such a manner that they remain legible after installation and inspection has been completed.

D. Ductile Iron Pipe (DIP) and Fittings: Pipe and fittings shall conform to ANSI/AWWA C151/A21.51, ANSI/AWWA C110/A21.10, and ANSI/AWWA C153/A21.53 except as otherwise specified herein.

1. Design: All DIP shall meet the requirements of ANSI/AWWA C150/A21.50 and ANSI/AWWA C151/A21.51. The minimum thickness shall be Special Thickness Class 50.

2. Joints: Mechanical and push-on joints for pipe and fittings shall conform to the requirements of ANSI/AWWA C111/A21.11. Natural rubber gaskets shall not be accepted.

3. Restrained Joint Pipe and Fittings: Restrained joint pipe and fittings shall be per the pipe manufacturer's recommendation. American Flex-Ring, US Pipe TR Flex, US Pipe Bolt-Lok, US Pipe Mech-Lok, and McWane TR Flex are considered restrained joints.

4. Coatings: The pipe exterior shall be coated with a layer of arc-sprayed zinc per ISO 8179 with a mass of 200 g/m2. Pipe markings shall include the word "ZINC". The

zinc shall be covered with a standard thickness exterior bituminous coating complying with ANSI/AWWA C151/A21.51.

5. Linings: Pipe and fittings shall have a hydrogen sulfide resistant ceramic quartz filled amine cured novalac epoxy interior lining, 40 mil nominal thickness. Refer to the Water Utilities Approved Products List.

6. Polyethylene Encasement: All ductile iron pipe and fittings shall be installed with a polyethylene tube encasement that is a co-extruded 3 layer film enhanced with a corrosion inhibitor and a biocide complying with AWWA/ANSI C105/A21.5 with a minimum thickness of 0.08 inches (8 mils).

E. HDPE Pipe and Fittings: Pipe and fittings shall conform to ANSI/AWWA C901 and ANSI/AWWA C906 except as otherwise specified herein.

1. Material: The pipe and fittings shall be made of polyethylene (PE) plastic having a grade if PE34 with a minimum cell classification of 345464C, as defined in ASTM D 3350.

2. Design: All HDPE pipe and fittings shall meet the requirements of ANSI/AWWA C901 and ANSI/AWWA C906. Pipe shall have a minimum wall thickness complying with DR 11. The pressure class shall be 2.0 times the sum of the working pressure and 100 psi surge allowance.

3. Fittings: HDPE fittings shall comply with ANSI/AWWA C906 and the requirements of ASTM D 2683 for socket-type fittings, ASTM D 3261 for butt heat fusion fittings, and ASTM F 1055 for electrofusion type fittings.

F. Concrete: Concrete shall be a MoDOT Class B-1 Air Entrained mix or KCMMB 4k mix , unless otherwise shown on plans. .

G. Granular Bedding Aggregate Material: See Section 2100.

H. Backfill: See Section 2100.

I. Flowable Backfill: Flowable backfill shall consist of Controlled Low Strength Material (CLSM) complying with the requirements of Section 2100, Mix Design Type A.

J. Trench Checks: Trench checks shall consist of flowable backfill as specified in Paragraph 3501.I.

K. Pipe Encasement: Concrete used for pipe encasement shall be a MoDOT Class B-1 Air Entrained mix or KCMMB 4k mix. Reinforcing steel shall be new billet steel complying with the requirements of ASTM A 615, Grade 60.

L. Pipe Collars: Concrete, whether reinforced or non-reinforced, used for pipe collars shall be a MoDOT Class B-1 Air Entrained mix or KCMMB 4k mix. Reinforcing steel, when

required, shall be new billet steel complying with the requirements of ASTM A 615, Grade 60.

M. Pipe Anchors: Concrete, whether reinforced or non-reinforced, used for pipe anchors shall be a MoDOT Class B-1 Air Entrained mix or KCMMB 4k mix. Reinforcing steel, when required, shall be new billet steel complying with the requirements of ASTM A 615, Grade 60.

N. Building Sewer Stubs: Building sewer stubs shall be SDR 26 (minimum) PVC.

O. Casing pipe

1. Pipe

a. The casing pipe shall be made of steel, meeting the requirements of ASTM A 139, grade B, with a minimum yield strength of 35,000 psi.

b. The minimum wall thicknesses required are shown in the following table:

c.

Casing Diameter (inch)	Minimum Wall Thickness
10, 12, 14, 16	0.188” (3/16”)
18, 20, 22	0.250” (1/4”)
24, 26	0.281” (9/32”)
28, 30, 32, 34	0.312” (5/16”)
36, 38, 40, 48	0.344” (11/32”)

2. Pipe Supports:

a. Casing Spacers: Casing spacer shall be a two-piece shell or band made from T-304 stainless steel of a minimum 14-gauge thickness. The shell/band shall have risers made of 10-gauge T-304 stainless steel and have a PVC liner. The bearing surface (skid or runner) shall be made of an ultra-high molecular weight polymer, glass reinforced polyester, or fiberglass reinforced nylon. The shell/band shall be bolted together with T-304 stainless steel bolts. The configuration of the carrier pipe in the casing pipe shall be centered. End seals shall be made by the same manufacturer as the casing spacers and shall use stainless steel bands to hold end seals to pipes.

b. Ends of the Casing Pipe: The ends of the casing pipe shall be closed with a manufactured end seal (see the Standard Drawings).

P. Manholes

1. Precast Sections: Precast concrete manholes shall conform to ASTM C 478 with the following modifications.

a. Wall thickness not less than one-twelfth of inside diameter, or 4 inches, whichever is greater, shall be used.

b. Cement, fine aggregate, coarse aggregate and water used in the manufacture of precast manholes shall be as specified in KCMMB or MoDOT materials for concrete.

c. Integral cast bases shall be used unless prior approval is obtained from the City Engineer. The diameter of the base pad shall be 8 inches greater than outside diameter of the manhole.

d. Pipe penetrations shall be fitted with a flexible pipe-to-manhole connector. Refer to the Water Utilities Approved Products List.

e. The minimum distance from the invert of the downstream pipe to the top surface of the base shall be 3 inches.

f. Riser Rings

i. HDPE: Injection-molded HDPE adjusting rings as manufactured by Ladtech, Inc.

2. Cast-In-Place-Concrete: Concrete shall be a MoDOT Class B-1 Air Entrained mix or KCMMB 4k mix.

3. Reinforcing Steel: Reinforcing steel shall be new billet steel complying with the requirements of ASTM A 615, Grade 60.

4. Joint Sealant

a. Between Precast Sections: Joints between precast manhole pipe sections and between the manhole casting frame and precast manhole pipe sections shall be sealed with preformed butyl joint sealants meeting the requirements of ASTM C 990. The minimum bead dimension shall be 1 square inch. The butyl component of the preformed joint sealant shall consist of 60 percent (minimum) butyl rubber. Preformed joint sealants shall remain flexible at temperatures as low as 0° F. Refer to the Water Utilities Approved Products List.

b. Exterior of Joints: The exterior of all joints including the joint between the manhole casting frame and the precast manhole pipe sections shall be sealed with one of the following:

i. Press-Seal EZ-Wrap Butyl joint wrap with rubber backing, 6-inch wide, or an approved equal: The butyl component of the tape shall consist of 50 percent (minimum) butyl rubber, shall contain 2 percent or less volatile matter, and shall be 0.030 inches thick. The backing component shall be EPDM rubber. A release paper may be utilized. Refer to the Water Utilities Approved Products List.

ii. Heat-shrinkable joint wrap complying with ANSI/AWWA C216: The wrap system shall consist of a two-part material (backing + adhesive) with a closure system and a compatible primer. It shall consist of an irradiated and cross-linked polyolefin sheeting, pre-coated with a layer of anti-corrosion adhesive. The backing shall have a minimum recovery of 22%. The adhesive shall be a mastic-type, specially formulated to become fluid at temperatures achieved during installation and maintain flexibility in cold climates with installation temperatures down to -40°F. Upon cooling the adhesive shall form a tough, elastomeric protective layer. The wrap shall employ a closure seal to allow sealing of the overlap area. The overall thickness of an applied sleeve shall nominally measure 0.100 inches (2.5 mm). Refer to the Water Utilities Approved Products List.

iii. The casting shall be sealed to the structure with an external sealing system. The seal shall be a continuous band, made of EPDM (Ethylene Propylene Diene Monomer) rubber with a minimum thickness of 65 mils. Each unit shall have a 2" wide mastic strip on the top and bottom edge rubber band. The mastic shall be non-hardening butyl rubber sealant, with a minimum thickness of ¼", and shall seal to the cone/top of the manhole and over the lip of the casting. Refer to the Water Utilities Approved Products List. Prior to placement of the mastic against the manhole or casting, the surfaces shall be coated with a primer capable of enhancing the mastic adhesion. The primer coat shall cover the entire surface area where the mastic is intended to adhere. Refer to the Water Utilities Approved Products List.

5. Non-Shrink Grout: Non-shrink grout shall be in the plastic state and show no expansion after set as tested in accordance with ASTM C 827 and shall develop compressive strength not less than 3,000 pounds per square inch with a trowelable mix within 24 hours per ASTM C 109. The placement time shall be not less than 45 minutes based on initial set per ASTM C 191.

6. Gasket: Pipe openings shall contain flexible gaskets complying with the requirements of ASTM C 923. Refer to the Water Utilities Approved Products List.

7. Waterproofing: All precast sections shall be waterproofed prior to shipment to the project site. Waterproofing shall be accomplished using one of the following coatings:

   a. When a sewage force main terminates in a manhole, the internal surface of the first two receiving manholes shall be lightly sandblasted and coated with a total dry film thickness of not less than 8.0 mils of Tnemec Series 69 Hi-Build Epoxiline II or approved equal.

   b. Exterior manhole surfaces shall be coated with one of the following materials:

      i. A total dry film thickness of not less than 14.0 mils of bituminous coating.

      ii. A total dry film thickness of not less than 4.0 mils of Tnemec Series 66 Hi-Build Epoxiline or approved equal.

8. Manhole Steps: Steel core plastic coated steps shall meet the following minimum requirements:

    a. The standard plastic coated step shall be as referenced in the Water Utilities Approved Products List.

    b. The plastic coating shall be a copolymer polypropylene complying with ASTM D 4101 with a classification of PP0344B33534Z02 or better.

    c. The steel core shall be a minimum of ½ inch in diameter and shall conform to ASTM A 615, grade 60.

9. Manhole Castings

    a. Material for all iron castings shall comply with the requirements of "Drainage Structure Castings," AASHTO M306, Section 3, except if cast iron is used, it shall be ASTM A48/AASHTO M105, Class 30B or better.

    b. Workmanship and Finish: Manhole castings shall comply with the requirements of AASHTO M306, Paragraphs 4.1 and 5.1. All castings shall be manufactured true to pattern and component parts shall fit together in a satisfactory manner.

    c. Seating and Bearing Surfaces: All horizontal-bearing surfaces shall be machined. Castings shall conform to the requirements of AASHTO M306, Paragraph 4.3.

    d. Rating: Castings shall be heavy duty and capable of handling loads of at least 40,000 pounds. Proof-load testing shall conform to the requirements of AASHTO M306, Section 7. Proof-load testing is not required for the adapters (Lee's Summit ID Nos. LS106A-D, LS107A-D).

    e. Markings:

        i. Imported castings shall meet the country-of-origin markings as required in Title 19, Code of Federal Regulations, Part 134 (19 CFR 134).

            Lettering for country-of-origin marking shall not exceed 1 ½ inches.

        ii. Castings shall conform to the requirements of AASHTO M306, Section 11. Julian heat date shall be cast, not stamped, into the castings.

    f. Dimensional Tolerances: The dimensions of all castings shall be within the permissible variations specified in AASHTO M306, Paragraph 4.2, except 4.2.4 shall be replaced with the following: Each casting shall weigh at least 95% of the weight for its specific type as stated by the manufacturer.

    g. Frames and Covers: Frames and covers shall meet the following minimum requirements:

i. Critical dimensions and Lee's Summit part numbers are as shown in the table below.

ii. All manhole frames (except the slab bolt-down manhole frame) shall be designed and delivered with a full mud ring. Partial projections shall not be accepted.

iii. All covers shall have two concealed pick holes that meets the manufacturer's requirements.

iv. All covers shall have the "City of Lee's Summit" and "Sewer" cast into the piece in 1 ½-inch and 3-inch letters, respectively.

v. Castings shall be fully interchangeable in the field with the equivalent Clay & Bailey models indicated in Paragraph 3501.P.9.h.vi.below.

vi. All parts shall have a Lee's Summit part number cast into the piece in 1-inch letters. Location of the part number shall be such that when the part is installed, part number shall be readily visible without excavation of adjacent material. Part numbers shall be as shown below:

Part No.	Description
LS101A	Standard 24" Manhole Frame (Clay & Bailey 2007MR) - Matching cover is LS101B
LS101B	Standard 24" Manhole Cover (Clay & Bailey 2007) - Matching frame is LS101A
LS102A	Bolt-down Manhole Frame (Clay & Bailey 2014OR) - Matching cover is LS102B
LS102B	Bolt-down Manhole Frame Cover (Clay & Bailey 2014OR) - Matching frame is LS102A
LS103A	Slab Manhole Frame (Clay & Bailey 2002) - Matching cover is LS103B
LS103B	Slab Manhole Cover (Clay & Bailey 2007) - Matching frame is LS103A
LS104A	Slab Bolt-down Manhole Frame (Clay & Bailey KCMO R4) - Matching cover is LS104B
LS104B	Slab Bolt-down Manhole Cover (Clay & Bailey KCMO R4) - Matching frame is LS104A

vii. Covers marked with other cities' names and/or logos shall not be accepted.

viii. Covers located in the street right-of-way or adjacent utility easement shall be hot-dipped asphalt coated.

ix. Refer to the Water Utilities Approved Products List.

10. Epoxy Manhole Liner: Epoxy manhole liners shall be installed inside the first two receiving manholes downstream of force main sanitary sewer system and shall meet the following minimum requirements:

a. Epoxy Manhole Liner for Manholes: The epoxy manhole liner shall be chemical resistant (below a pH of 2.0), VOC compliant, moisture tolerant, 100% solids, two (2) component epoxy system with the following properties:

Flexural Strength [ASTM D-790]:	>10,000 psi
Compressive Strength [ASTM D-695]:	>10,000 psi
Tensile Strength [ASTM D-638]:	>7,000 psi
Adhesion:	Concrete Substrate Failure

b. Refer to the Water Utilities Approved Products List.

Q. Utility Markers:

1. Utility marker tape shall be minimum 2 inches wide, 4-mil thick green plastic tape with the word “SEWER” lettered in permanent black graphics.

2. In addition to utility marker tape, PVC and HDPE force main shall have a tracer wire installed along the top of the pipe. The wire shall be insulated, no smaller than 12 gauge, and for underground applications.

3. Splices in wiring shall be made with a locking splice connector manufactured with a waterproof dielectric sealant. Refer to the Water Utilities Approved Products List.

4. Tracer wire shall be installed along the top of all mains and service laterals. All service lateral trace wires shall be properly connected to the main tracer wire. The main tracer wire shall be laid continuously, by-passing around the outside of manhole structures. Tracer wire installed using open trench installation shall be #12 AWG copper clad steel with a minimum 30 mil HDPE insulation thickness. The tracer wire shall be green in color. Tracer wires shall terminate at the ground surface inside a tracer box. Tracer box lids shall be green in color. Tracer wire shall be grounded to a minimum one-pound magnesium grounding rod at the sewer line.

3502 CONSTRUCTION AND INSTALLATION

A. General

1. Notification

a. Disruption of Sanitary Sewer Service:

i. When a disruption of sanitary sewer service will occur, the Contractor shall notify Water Utilities Operations at least 48 hours in advance to make the necessary arrangements.

ii. It shall be the Contractor's responsibility to place door hangers on the affected premises at least 24 hours in advance of the disruption. The door hanger shall indicate the date and time of the disruption and its anticipated length.

b. The Contractor's work shall be scheduled in a manner to accommodate the schedules of the City and the affected customers.

2. Protection of Existing Water Mains, Sewers, Structures, or Utilities

a. Where new lines approach, cross, connect to, or run parallel to existing water or sewer mains, the Contractor shall be held completely responsible for protecting, preserving, and otherwise maintaining existing line during construction of new line. Any damage inflicted to water and sanitary sewer mains or structures must be promptly reported to Water Utilities Operations and arrangement made for the repair. Any damage inflicted to storm sewer lines or structures must be reported promptly to the Public Works Operations Division and arrangement made for repair. Any damage inflicted to any other utility must be reported promptly to the respective utility and arrangement made for the repair.

b. Where new construction interferes with operation of existing mains, Contractor shall provide bypass lines or other temporary connections are required to maintain continuous service.

c. The Contractor shall protect all existing structures, utilities, and work of any kind against damage or interruption of service that may result from the operations of the Contractor. Damage or interruption of service resulting from failure to do so shall be repaired or restored promptly at the expense of the Contractor.

d. The Contractor shall give reasonable notice to utility companies and to other owners of property when such property is liable to damage or injury could result from the execution of the Work, so that the owners of such utility or property may take precautionary measures.

e. The Contractor shall be responsible to adjust to finish grade any existing utility/appurtenances (i.e. valves, meter wells, sanitary sewer manhole, storm junction box etc.) that is affected by construction.

3. Handling and Storage

a. Handle pipe materials and fittings in a manner to assure installation in sound and undamaged condition. Use slings, lifting bags, hooks, and other devices designed to protect pipe, joint elements, and coatings. In handling plastic pipe of 10 feet long or greater, a double sling will be required.

b. Ship, move, and store with provisions to prevent movement or shock contact with adjacent units.

c. Pipe shall be handled in a manner that minimizes the damage to the coating. Damaged coating shall be repaired in a manner complying with the pipe manufacturer's recommendations.

4. Inspection of Materials: All pipe, fittings, and accessories shall be examined by the Inspector prior to installation for soundness and specification compliance. Rejected materials shall be marked and removed from the project site, and replaced with approved materials.

5. Alignment: Pipe shall be laid to the lines and grades as shown on the approved Engineering Plans.

6. Cleaning: All pipe, fittings, and accessories shall be kept clean of foreign matter while being handled or stored. During installation, foreign matter shall not enter the pipe or appurtenances. At the end of each working day, a temporary plug shall be installed at the termination of the pipeline.

B. Sanitary Sewer Installation

1. Installation Standards: All pipes shall be installed in accordance with the following standards:

a. DIP - ANSI/AWWA C 600.

b. PVC Pipe - ASTM D 2321.

c. HDPE Pipe - Plastics Pipe Institute, "Underground Installation of Polyethylene Pipe".

2. Installation

a. Governmental Requirements: Sanitary sewer main installation shall comply with applicable local, State, and Federal requirements.

b. Trench Dewatering: See Section 2100.

c. Drainage Course Crossings: See Section 2100.

d. Trench Widths

i. Minimum Widths: Trench widths and pipe clearances shall be not less than those shown in the following table.

MINIMUM TRENCH WIDTHS AND PIPE CLEARANCES (in)

Nominal Pipe Diameter	Trench Width[1]	Pipe Side Clearance[2] (Soil/Rock)	Pipe Bottom Clearance (Soil/Rock)
6	22	6/6	6/6
8	22	6/6	6/6
10	24	6/6	6/6
12	27	6/6	6/6
15	30	6/6	6/6
18	34	6/6	6/6
21	39	7/9	6/9
24	43	7/9	6/9
27	48	8/9	6/9
30	54	8/9	6/9

[1] Measured below a horizontal plane 6 inches above the top of the pipeline.

[2] Measured from the outside face of pipe barrel to inside face of trench.

ii. Maximum Widths

(a) Maximum trench widths shall not exceed the manufacturer's recommendations.

(b) The allowable maximum trench widths hereinafter specified apply only to that portion of the trench below the horizontal plane parallel to and 6 inches above the top of the pipe.

(c) The allowable maximum widths may be exceeded at manholes, bore pits, tees, and in unstable earth material. Where the maximum trench width is exceeded, the Contractor shall provide appropriate embedment as indicated by the Design Engineer and the City Engineer.

iii. Trench Slope: See Section 2100.

iv. Trench Shields: See Section 2100.

e. Compacted Fill: See Section 2100.

f. Pipe Embedment: All pipe shall be bedded in bedding material with a minimum thickness beneath the pipe as specified in Paragraph 3502.B.2.d. See Section 2100.

g. Bedding Installation: See Section 2100.

3. Backfill: See Section 2100.

4. Utility Marker Tape: Install utility marker tape above the centerline of each sewer line. Bury marker tape 18 to 24 inches below finished grade, along the full length of the sewer line. When tracer wire is required, the tracer wire shall be installed along the

top of the pipe on all mains and services so that the wire is in relatively continuous contact with the pipe and shall be for underground applications. The wire shall be accessible at every manhole, vault or tracer box. Marker tape and tracer wire shall be inspected by the City inspector prior to backfill. All tracer wires shall be tested before acceptance. Any tracer wire broken during installation shall be repaired by the Contractor. All tracer wires shall be tested after all other acceptance tests have passed.

5. Wyes and Building Sewer Stubs: Wyes and building sewer stubs shall be installed as shown on the Engineering Plans or specified herein.

    a. Building sewer stubs shall be adequately plugged to prevent foreign matter from entering the pipe during construction.

    b. Wyes shall be installed at a maximum vertical angle of 45 degrees and not less than 30 degrees from the centerline of the main to the centerline of the sewer stub, for pipe sizes 8- through 16-inch diameters. Wyes shall not be installed in pipe sizes equal to or greater than 18 inches in diameter.

    c. When the building sewer stub grade exceeds 20 percent, pipeline anchors shall be installed as required under Paragraph 6501.E.7 with the first anchor not more than 12 or less than 5 feet upstream of the wye.

    d. All building sewer stubs shall be constructed bell to spigot.

    e. For new construction, where a wye has been provided for a private building sewer, a second wye shall not be provided (cut-in by the builder).

    f. The Contractor shall maintain an accurate record for submittal to the Design Engineer of location, size, and direction of each wye and insertable fitting and the elevation, location, size, and length of each building sewer stub. Locations shall use the pipeline stationing as shown on the Engineering Plans.

6. Gravity Sewers: All gravity sewers shall be installed to the alignment, elevation, slope, and with pipe embedment as specified and/or shown on the Engineering Plans.

7. Pipe Encasement, Collars, Anchors, and Trench Checks

    a. Concrete construction shall comply with ACI 301, Specifications for Structural Concrete.

    b. Total or partial encasement of pipe in concrete shall be used where the required safe supporting strength of the pipe cannot be obtained by other bedding methods. Concrete encasement shall also be provided at locations to protect public water supplies or where there exists the possibility that standard bedding may be eroded by currents of water under and around the pipe.

    c. Concrete encasement shall be constructed at locations indicated and in accordance with details as shown on the Engineering Plans and in the Standard Drawings.

Start and terminate encasement at a pipe joint. Adequately support and block the pipe to maintain position and prevent flotation. Form to dimensions indicated or construct full width of a trench.

i. Longitudinal reinforcement shall be continuous.

ii. Concrete encasement shall be protected and cured so as to prevent excessive evaporation of moisture or freezing. Backfilling will not be considered as a suitable method of curing the encasement.

iii. Backfill trench only after concrete encasement has obtained a minimum of 2000 psi. All backfilling shall be done in accordance with Section 2100.

d. Collars shall be constructed at locations indicated on and in accordance with details shown on the Engineering Plans and in the Standard Drawings.

e. Anchors shall be constructed at locations indicated on and in accordance with details shown on the Engineering Plans and in the Standard Drawings.

f. Trench Checks: Trench checks shall be constructed at locations indicated on and in accordance with details shown on the Engineering Plans and in the standard drawings. They shall consist of flowable backfill and extend 12 inches below the bottom of the pipe. Length shall be a minimum of 12 inches and width shall be the width of the trench. The height of the trench check shall extend to 12 inches above the top of the pipe.

8. Pipe Laying: All pipe shall be installed in accordance with the pipe manufacturer's recommendations, except as modified herein.

a. Pipe laying shall not proceed if the trench width as measured at the top of pipe exceeds the maximum allowable trench width. If this occurs, the Contractor shall submit to the Design Engineer for approval a better bedding for the pipe or pipe of sufficient strength to provide safe supporting strength.

b. All pipe and fittings shall be stored and handled with care to prevent damage thereto. Do not use hooks to transport or handle pipe or fittings. Do not drop pipe or fittings.

c. Pipe and fittings rejected by the Inspector shall be marked and removed from the project site. All pipe and fittings shall be examined for soundness and specification compliance prior to placement in the trench and rejected pipe or fittings shall not be incorporated into the pipeline. Check the class or pipe strength to be sure proper pipe is installed.

d. Clean joint contact surfaces prior to jointing. Use lubricants, primers, or adhesives as recommended by the pipe or joint manufacturer. Keep lubricants and applicators clean.

e. Pipe laying shall begin at the lowest point. The Contractor will not be allowed to lay any pipe if manholes are not on the project site. The pipe laying upstream of a manhole shall not proceed until the base of the manhole has been placed and leveled.

f. Unless otherwise required, lay all pipe straight between manholes. Excavate bell holes for each pipe joint. When jointed, the pipe shall form a true and smooth pipeline.

g. The alignment of all pipelines between adjacent manholes shall be true to line and grade. The pipeline from manhole to manhole shall reflect the full bore of the pipe. The pipe shall be truly centered into the abutting pipe.

h. The grade lines shown on the profile drawings extend from the centerline of the top manhole to the centerline of the bottom manhole. The pipes and appurtenances shall be truly laid to line and grade throughout, all junctions and other pieces required shall be properly excavated for and laid as shown on the Engineering Plans, and the following tolerances from true horizontal alignment and vertical grade shall be maintained:

Horizontal Alignment:	$\pm$12 inches
Vertical Grade:	$\pm$ 0.1 feet

Pipe installed but not meeting these tolerances shall be ordered removed and replaced at the Contractor's expense.

i. The sewer trench shall be excavated to sufficient depth to allow embedment to be placed in the bottom of all trenches. At the pipe joints, the trench shall be excavated to an additional depth so that the bell will not rest on the bottom of the trench, and all the weight of the pipe shall be evenly distributed along the entire length of the barrel of the pipe.

j. The sewer must be made watertight at all points; any leaks or other defects discovered at any time before the final acceptance of the Work shall be immediately repaired or that portion of the sewer shall be rebuilt if necessary.

k. In all cases, full length sticks of pipe shall be used, except in making closures.

l. Clean interior of all pipe, fittings, and joints prior to installation. To exclude entrance of foreign matter during discontinuance of installation, close open ends of pipe with snug fitting closures. Take reasonable precautions to not let water fill the open trench, and include provisions to prevent pipe flotation. Remove water, sand, mud, and other undesirable backfill materials from trench before removal of end cap.

m. In forming joints, each length of pipe shall be carefully aligned in such manner as to form an accurate concentric joint, thus providing a uniform circular pipe opening. Each length of pipe shall thrust into the bell and shall be securely held in

position until the next length of pipe has been placed. Insofar as possible, commence laying of downstream end of line and install pipe with spigot or tongue end downstream.

n. The pipeline trench excavation shall be dewatered sufficiently to allow pipe joints to be made under dry conditions. No joints shall be made under water.

o. Joints:

i. Joints shall in general be made in accordance with the manufacturer's recommendations and as specified herein. All joints to be welded or fused shall be performed by a technician certified by the manufacturer.

ii. Clean and lubricate all joint and gasket surfaces with lubricant recommended by pipe manufacturer.

iii. Care shall be exercised by the Contractor to insure against damage to joint material in storage, handling, or placing operations.

iv. No damaged joint material shall be permitted to be used, and the same shall be removed from the job site.

v. All pipe joints shall be completed by insuring that the ends of the pipe to be joined are in contact and completely shoved into "home" position.

p. Pipe shall be cut in a neat workmanlike manner without damage to pipe. Cutting of pipe with a torch is not permitted. Smooth cut by power grinding to remove burrs and sharp edges. Repair the lining as required and approved by the Inspector.

q. All pipelines shall be plugged at the end of each day's progress. Plugs or other positive methods of sealing shall be utilized at all times to protect any existing system from entrance of storm water or other foreign matter.

r. Crossings:

i. Sewer mains crossing water mains shall be installed providing a minimum vertical clear distance of 18 inches between the outside of the sewer main and the outside of any water main. This shall be the case where the sanitary sewer main is either above or below the water main.

ii. At crossings, a full length of sewer pipe shall be located such that both joints will be as far from the water main as possible.

iii. Where conditions prevent the minimum vertical separation set forth above from being maintained, the following shall be applied:

(a) The sewer line shall be laid with ductile iron pipe which shall extend on each side of the crossing to a distance from the water main of at least 10 feet.

(b) In making such a crossing, a full length of ductile iron pipe must be centered over or under the water main to be crossed so that the joints will be equidistant from the water main.

iv. Provide special structural support for the pipes as necessary.

v. Minimum crossing angle shall be 45 degrees.

9. Temporary Plugs

   a. Provide and install plugs as manufactured by pipe supplier or as fabricated by Contractor if approved. Plugs shall be watertight against hydraulic heads up to 20 feet. Secure plugs in place in a manner that facilitates removal when required to connect pipe.

   b. Plugs shall be installed as specified or where shown on Engineering Plans. Also the open end of the sewer shall be plugged at the end of the work day with a suitable mechanical plug to prevent entry of foreign material until work is resumed.

10. Removal of Water: The Contractor shall provide dewatering as specified in Section 2100. Damaged pipe or structures of any kind resulting from insufficient dewatering facilities or similar lack of proper conduct of the work shall be replaced by the Contractor at their own expense. No structure or pipes shall be laid in water, and no water shall be allowed to run into or over any concrete work or pipe, or into or through any pipe.

11. Sewer Main Connections to Existing Pipelines and Structures

    a. General: Connect pipe to existing structures and pipelines where indicated.

    b. Tying a Sewer Main to an Existing Manhole: Prepare structure by making an opening with manufacturer's recommended clearance all around fitting to be inserted. The concrete structure shall be core drilled, and a flexible pipe-to-manhole connector/gasket shall be installed in such a manner that a watertight condition will result. Refer to the Water Utilities Approved Products List for flexible pipe-to-manhole connectors/gaskets.

    c. Adding a Manhole onto an Existing Sewer Main:

       i. The Contractor shall cut the existing sewer main, set a pre-cast base onto a 6-inch thick (minimum) crushed rock bedding layer, and insert sewer pipe through the manhole to connect the existing ends of the sewer main. The ends may be connected to the existing sewer through the use of rigid couplings if a bell(s) is (are) not available. The inverts may be formed using non-calcium chloride high-early strength concrete.

ii. Any portion of the existing sewer damaged by the Contractor shall be repaired or replaced. Any damaged vitrified clay pipe shall be replaced with PVC pipe, as a minimum, or DIP if required by its location.

iii. Bypass pumping shall be required and shall be coordinated with the City Inspector.

d. Pipe Connecting to a Structure: Pipe connecting to a structure shall be supported with bedding aggregate as specified in Section 2100.

12. Connection of Pipes of Dissimilar Materials:

a. General: The connection of pipes of different materials shall be made using approved transition couplings, and shall provide a permanent and watertight connection that will withstand the hydrostatic test pressure.

b. Pipe Diameters less than 15 Inches: Connections between different pipe materials less than 15 inches in diameter shall be made using a Maxadaptor coupling or approved equal unless otherwise specified on the Engineering Plans.

c. Pipe Diameters Greater than or Equal to 15 Inches: Connections between different pipe materials greater than or equal to 15 inches in diameter shall be made using a Fernco Strong Back coupling. The coupling shall be encased in MoDOT Class B-1 Air Entrained mix or KCMMB 4k mix to a level 6 inches above the top of the pipe material unless otherwise specified on the Engineering Plans.

13. Abandonment of Building Sewer Stubs

a. Building Sewer Stubs shall be disconnected from the sewer main when buildings are demolished and future reuse of the sewer stub is not anticipated or the sewer stub is not compliant with the applicable codes and standards in effect at the time.

b. Building sewer stubs shall be disconnected from the sewer main when property that contains sewer stubs is re-platted and those sewer stubs are no longer necessary for future development.

c. A building sewer stub may be left in place and reused for future development if the stub and the connection to the main are complaint with the codes and standards in effect at the time, if it is capped with a water tight seal at or near the edge of the right-of-way and it is marked by vertically burying a 2”x4” with a steel spike from the end of the sewer stub to the surface of the ground.

d. Building sewer stubs being disconnected from the sewer main shall be disconnected by the Water Utilities Department, after the contractor has provided access to the sewer main via an OSHA compliant excavation with proper shoring as necessary. Water Utilities staff reserve the right to not enter any trench determined to be unsafe.

14. Abandonment of Sewer Mains

    a. Prior to abandonment of a sewer main, the Contractor shall contact the Water Utilities Department to verify that no existing services will be affected. Building sewer stubs shall be properly abandoned prior to abandoning the sewer main.

    b. Sewer mains shall be abandoned by plugging each end of the line segment with a 1- foot thick plug of non-shrink grout sealed with Portland Cement Grout, or removed, backfilled and restored as directed by the Water Utilities Department.

15. Protection of Water Supplies

    a. There shall be no physical connection between a public or private potable water supply system and a sewer, or an appurtenance thereto, that would permit the passage of any wastewater or polluted water into the potable water supply.

    b. Sewer mains, i.e., house connections, building sewers, trunk lines, interceptors, force mains, etc., shall not be constructed within a 100-foot radius of a public water supply well. Greater separation may be required where soil and drainage conditions indicate the need for greater protection. Sewer mains constructed of DIP may be constructed within 10 feet of a private water supply well. Sewer mains constructed of other materials must be at least 50 feet from a private water supply well.

    c. For sewer mains paralleling or crossing water mains, see Paragraph 6501.E.1.c.

    d. Water and sewer mains shall not be placed in the same trench or excavation.

C. Acceptance Tests for Completed Sewers

1. General

    a. The Contractor shall furnish all labor, equipment, water, materials, and reports for the required acceptance tests. All pipelines, including building sewer stubs, shall undergo and pass all required tests to determine soundness and workmanship. Pipelines that do not comply with the City of Lee's Summit Standard Specifications shall be repaired and/or replaced and shall be retested until the pipeline meets said specifications.

    b. No testing shall be performed before backfill and compaction operations have been completed unless otherwise approved by the Inspector. Testing for sanitary sewers shall begin no sooner than 30 days after completion of all sanitary sewer.

    c. After backfilling has been completed, the Contractor shall conduct all testing in the presence of the Inspector.

    d. Each reach of sewer shall meet the requirements of the acceptance tests. All defects shall be repaired to the satisfaction of the Inspector.

e. The Contractor shall clean and flush with clear water the pipe of excess mortar, joint sealant, and other dirt and debris prior to inspection.

2. Sewer Pipe Alignment and Grade Testing: Alignment, grade and visible defects shall be checked as follows:

a. Sewer Pipe Deflection Testing: Flexible pipelines (i.e., PVC pipe) shall be tested for deflection by pulling a mandrel through the entire length thereof.

i. The mandrel (go/no-go) device shall be cylindrical in shape and constructed with nine evenly-spaced arms or prongs. Mandrels with fewer arms will be rejected as not sufficiently accurate. The dimensions of the mandrel shall be as listed in the table below. The mandrel diameter dimension shall carry a tolerance of ±0.01 inch. Allowances for pipe wall thickness tolerances or ovality (from heat, shipping, poor production, etc.) shall not be deducted from the mandrel diameter dimension but shall be counted in as part of the 5 percent or lesser deflection allowance. Contact length shall be measured between points of contact on the mandrel arm. The length shall not be less than as shown in the table below.

Nominal Diameter (in)	**Mandrel Length (in)**	**Mandrel Diameter (in)[1]**	
		SDR 26[2]	**SDR 21[3]**
8	8	7.37	7.41
10	9	9.21	9.21
12	10	10.96	10.96
15	12	13.42	N/A
18	15	N/A	15.47
21	16	N/A	N/A
24	18	N/A	20.63
27	27	N/A	N/A

[1] Mandrel diameter = [avg. outside diameter - 2*(min. wall thickness)]*0.95

[2] Calculated using values from ASTM D3034.

[3] Calculated using values from ASTM D2241.

ii. The Inspector shall be responsible for approving the mandrel. In the event the Contractor provides the mandrel, he/she shall provide proving rings to verify this. No mandrel testing will be witnessed or approved by the Inspector without completion of the aforementioned verification of the mandrel size for the Work.

iii. The mandrel shall be hand-pulled by the Contractor through all sections of PVC sewer mains. Any sections of sewer not passing the mandrel test shall

be uncovered, and the Contractor shall re-round or replace the sewer to the satisfaction of the Inspector. These repaired sections shall be retested.

iv. Sections of DIP sewer main shall be visually checked for deflection, i.e., not deflection tested with the mandrel due to the potential for damaging the cement mortar lining.

b. Television/Video Inspection: Sewer mains installed as part of the Work are subject to inspection by closed circuit television prior to 1) issuing a Certificate of Substantial Completion and 2) the end of the correction period. Television / video inspection will be done twice by the City at the City's expense. If more than two television / video inspections are necessary, they shall be performed by the contractor. The contractor may choose to perform the television / video inspection in lieu of utilizing the City's service. If the contractor chooses to perform the television / video inspection, they shall contact the Water Utilities Department prior to performing the inspection. The television / video and inspection report shall be submitted to the City for its review. Any deficiencies noted shall be repaired at the expense of the Contractor.

3. Exfiltration-Infiltration Testing

a. General

i. Air pressure or hydrostatic tests shall be conducted on sewers before acceptance by the City. The exfiltration-infiltration shall not exceed 50 gallons per day per inch of nominal diameter per mile of sewer main for any section of the Work.

ii. Immediately prior to conducting a test, the groundwater level shall be determined by augering a vertical hole adjacent to the pipe and measuring the distance to the water level. Exfiltration head and air test pressures shall be adjusted for groundwater elevations over the top of the pipe.

b. Sewer Pipe Exfiltration Testing: Exfiltration tests shall be performed by the Contractor using one or a combination of the methods as set forth below. The required air pressure and/or exfiltration testing shall be successfully performed on carrier conduits prior to sealing of the ends of the casing conduits. PVC gravity sewer pipe shall be air tested.

i. Air Testing for PVC and DIP Gravity Sewer Mains

(a) The Contractor may perform air tests for all pipe sizes.

(b) Furnish all facilities required including necessary piping connection, test pumping equipment, pressure gauges, bulkheads, regulators to avoid over pressurization, and all miscellaneous items required.

(c) Each section of gravity pipeline between manholes and/or structures shall be tested after backfilling as outlined below and in accordance with ASTM F 1417. The time-pressure drop method specified in 8.2.2 of ASTM F 1417 shall be used.

(d) If the groundwater level is 2 feet or more above the top of the upstream end or if the test pressure required for the test is more than 9 psig, air testing should not be used.

(e) The pipe plug for introducing air to the sewer main shall be equipped with two taps. One tap will be used to introduce air into the line being tested through suitable valves and fittings, so that the input air may be regulated. The second tap will be fitted with valves and fittings to accept a pressure test gauge indicating internal pressure in the sewer pipe. Additional valves and fitting will be incorporated on the tap used to check internal pressure so that a second test gauge may be attached to the internal pressure tap. The pressure test gauge will also be used to indicate loss of air pressure due to leaks in the sewer main.

(f) The pressure test gauge shall meet the following minimum specifications:

Size (diameter)	4-1/2 inches
Pressure Range	0-15 psi
Figure Intervals	1 psi increments
Minor Subdivisions	0.05 psi
Pressure Tube	Bourdon Tube or diaphragm
Accuracy	+/-0.25% of maximum scale reading
Dial	White coated aluminum with black lettering, 270^{o} arc and mirror edge
Pipe Connection	Low male ½-inch N.P.T.

Calibration data not more than one year old shall be supplied with all pressure test gauges. Certification of pressure test gauges will be required from the gauge manufacturer. This certification and calibration data shall be given to the Inspector prior to the performance of any air tests conducted for the Work.

(g) Plug ends of line and cap or plug all connections to withstand internal pressure. Due to safety considerations, the Contractor must take care to brace both the end of the pipe and plug before introducing test pressure into the system. The Contractor can then connect the air control equipment to the air hose and begin to pressurize the system. During the pressurization process, the Contractor shall monitor the air pressure of the system so that internal pressure does not exceed 5.0 pounds per square inch gauge (psig). After reaching 4.0 psig, throttle the air supply to maintain between 4.0 and 3.5 psig for at least 2 minutes in order to allow equilibrium between air temperature and pipe walls. During this time, check all plugs to detect any

leakage. If plugs are found to leak, bleed off air, tighten plugs, and again begin supplying air. After temperature has stabilized, the pressure is allowed to decrease to 3.5 psig. At 3.5 psig, begin timing to determine the time required for pressure to drop to 2.5 psig. If the pressure begins to slowly drop from 3.5 psig and if the total time, in seconds, for the air pressure to decrease from 3.5 psig to 2.5 psig is greater than that shown in the table below, the pipe shall be presumed free of defects.

Pipe Size (in)	Minimum Time (min:s)	Length for Minimum Time (ft)	Time for Longer Length (s) L = Total Length
8	7:34	298	1.520 L
10	9:26	239	2.374 L
12	11:20	199	3.418 L
15	14:10	159	5.342 L
18	17:00	133	7.692 L
21	19:50	114	10.470 L
24	22:40	99	13.674 L
27	25:30	88	17.306 L
30	28:20	80	21.366 L

If air test fails to meet above requirements, repeat the test as necessary after all leaks and defects have been repaired and backfilled.

ii. Hydrostatic Tests for Gravity Systems:

(a) Test section shall be filled with water not less than 12 hours prior to testing. Refill the test section of pipe prior to performing the test.

(b) Perform at depths of water as measured above center line of pipe of not less than 4 feet or more than 10 feet (consideration shall be given for a water table above said centerline). Maintain the test as necessary to locate all leaks but not less than two hours.

(c) The Design Engineer shall determine the maximum allowable exfiltration rate for a given test section and then field verify that the maximum exfiltration rate has not been exceeded for that section. The maximum allowable exfiltration rate shall be approved by the City Engineer prior to testing.

c. Sewer Pipe Infiltration Testing: Where sewers are laid within the groundwater table, infiltration testing shall be conducted. Where the Inspector discovers evidence of infiltration, the Design Engineer and the City Engineer shall be contacted. The Contractor shall install weirs or other suitable flow rate measuring devices adequate to determine to the satisfaction of the City Engineer that the specified infiltration limit is not exceeded for that reach of gravity sewer. Where the specified infiltration limit is exceeded, the Contractor shall repair or replace the defective reach of the pipeline. Following repair of the pipeline, the Contractor

shall re-measure infiltration flow rates and make additional repairs until an acceptable infiltration flow rate is achieved.

D. Manhole Installation:

1. Bases

   a. Integral cast bases shall be reinforced in accordance with ASTM C 478. Precast integral cast bases shall be installed on a maximum of 6 inches of bedding aggregate. Depths exceeding this amount shall be filled with MoDOT Class B-1 Air Entrained mix or KCMMB 4k mix concrete mix.

   b. If integral cast bases cannot be used, cast-in-place concrete bases shall be used with the approval of the City Engineer. Cast-in-place bases shall be MoDOT Class B-1 Air Entrained mix or KCMMB 4k mix and have a minimum thickness of 12 inches. The bottom wall sections shall be embedded in the base section a minimum of 4 inches. The bottom precast wall section shall not be set upon a previously poured base. Wood shall not be used for supporting or leveling the wall section prior to pouring the base.

2. Inside Dimensions: The minimum horizontal clear distance in the barrel of the manholes shall not be less than 4 feet.

3. Precast

   a. Delivery: Precast concrete components shall not be delivered to the job until representative concrete control cylinders have attained at least 80 percent of the specified minimum design strength.

   b. Inspection: Precast concrete shall be inspected when delivered. Rejection of defective or cracked precast concrete components shall be in accordance with ASTM C 478.

   c. Construction: Precast sections shall be cleaned of all dirt, grass, and other deleterious matter. Seal wall and cone joints with a minimum of two beads of preformed butyl joint sealant. Seal the joints between the top of the cone, adjustment or riser rings and the manhole frame with a double bead of preformed butyl joint sealant. Sections shall be placed so that steps are aligned but without rotation or damage to sealant integrity. Lift holes in excess of 2 inches in depth shall be patched with non-shrink grout.

4. Cast-in-Place:

   a. Wall Thickness: Wall thickness shall conform to the dimensions as shown on the Engineering Plans.

   b. Construction: Reinforcement steel shall be placed as shown on the Engineering Plans. Tie-holes shall be patched with non-shrink grout. Wall sleeves, where

required, shall be installed as shown on the Engineering Plans. Water stops shall be installed at the wall and slab connection and shall be of the size, thickness, and material shown on the Engineering Plans.

c. Waterproofing: Interior protective coatings, where required, shall conform to the material specifications. Application shall conform to the manufacturer's recommendation.

5. Sealants. A double bead of preformed butyl joint sealer shall be applied to all joints. For the minimum bead dimension, see Paragraph 3501.P.44. The vertical spacing between manhole sections shall not exceed 1/4 inch. Joint sealants shall not be applied on damp or dirty surfaces.

6. Joint Wraps: The exterior of all joints, including the frame and cover assembly, shall be sealed with a 6-inch wide butyl joint wrap with rubber backing. Refer to the Water Utilities Approved Products List. The tape shall be overlapped at least twice its width. The tape shall not be stretched during application. Primer and/or adhesive, as recommended by the tape supplier, shall be employed for adverse, critical, or other applications.

7. Epoxy Manhole Liner: Installation of epoxy manhole liner shall consist of: cleaning the entire manhole interior surface, preparation of the manhole interior surface, frame seal, grade adjustment, cone/wall joint, pipe seals, bench and invert as required, and lining the manhole interior surface with a two component, 100% solids epoxy coating system which provides a durable, high strength, monolithic lining, at an average thickness of 125 mils with a minimum thickness of 120 mils. The first two manholes downstream of a force main entering the system shall be lined along with any other manholes identified on the Engineering Plans.

8. Gaskets. When gaskets are used, two gasket clamps shall be utilized at each pipe-to-gasket connection with the take-up screws for the gasket clamps being positioned a minimum of 90° apart.

9. Steps: Steps shall be aligned vertically below the casting and spaced at 16-inch centers. The top step shall be not more than 1 foot below the top of the cone. The lowest step shall be not more than 1 foot above the invert bench. Field drilled step holes are not permitted in precast concrete manholes unless approved by the Inspector.

10. Castings:

    a. Castings shall be installed with the mud ring inserted inside the manhole opening and resting on a minimum of two rows of preformed butyl joint sealant.

    b. Bolt-down castings shall be held in place as shown on the Engineering Plans.

    c. Bolt-down castings shall be bolted to the manhole, not to the adjusting ring.

11. Top Slabs: Thickness shall conform to the dimensions and reinforcement steel shall be placed as shown on the Engineering Plans.

12. Inverts: Inverts shall be at least MoDOT Class B-1 Air Entrained mix or KCMMB 4k mix and steel-troweled to produce a dense, smooth finish. The invert channel shall be "U" shaped in cross section and extend upward three-fourths of the inside pipe diameter. Smooth transitions shall be formed for pipes of different sizes, elevation, and bends. The invert bench shall be sloped to drain. In no case shall the inverts extend into the pipe or create areas that will allow for the accumulation of debris or interfere with flow through the manhole. .

13. Top Elevation: The finish top elevation of manhole castings shall conform to the following unless otherwise shown on the Engineering Plans or directed by the Inspector.

    a. In paved or future paved areas, the top of the casting shall conform to the slope of the pavement and be 1/8 inch below the finished pavement elevation.

    b. In non-pavement areas, the top of the casting shall be at the elevation shown on the Engineering Plans or as directed by the Inspector.

14. Manhole Adjustment: All new manholes will be provided with an adjustment ring(s) underneath the casting as shown on Engineering Plans. A maximum of two 6-inch or three 4-inch riser rings shall be installed on top of the cone section. Minimize the number of riser rings used. The joints shall be sealed with a double bead of preformed butyl joint sealant. If the top of an existing manhole is required to be raised to an elevation that will exceed 12 inches, or lowered more than the adjustment rings will allow, all vertical adjustments shall be made to the barrel of the manhole.

15. Manhole Backfilling: Manhole backfilling shall be governed by Section 2100. Any damage to the exterior manhole waterproofing shall be coated with 14.0 mils of bituminous coating prior to backfilling.

E. Acceptance Testing for Completed Manholes

1. General: All manholes and other structures installed or otherwise disturbed during construction shall be tested for infiltration-exfiltration by the method described herein. Infiltration-exfiltration testing shall be performed in the presence of the Inspector. The Contractor shall notify the Inspector 2 working days prior to beginning manhole testing. All visible leaks shall be repaired by the Contractor prior to testing and during the correction period.

2. Infiltration-Exfiltration Testing:

    a. For new manholes, lift holes penetrating the manhole wall in excess of 2 inches in depth shall be plugged with an approved non-shrink grout prior to testing. All pipes entering the manhole shall be plugged at least 8 inches into the sewer pipe. The plug shall be inflated at a location beyond the manhole/pipe. The plug and

pipe shall be braced securely to prevent either item from being drawn into the manhole.

b. Test Method: The vacuum test apparatus shall be placed inside or on top of the casting and the seal inflated according to manufacturer's directions as appropriate. A vacuum of 10 inches of mercury shall be drawn, and then the vacuum pump shall be shut off. With valves closed and hoses removed, the time shall be measured for the vacuum to drop to 9 inches of mercury. The manhole shall be acceptable if the time for the vacuum to drop from 10 inches to 9 inches is as follows:

Manhole Depth	**Time (min)**
10 feet or less	2.0
10.1 to 15.0 feet	2.5
15.1 to 25 feet	3.0
25.1 feet or greater	3.5

c. Resealing, repairs, and retesting shall be allowed at the discretion of the Inspector.

d. If the manhole fails the initial test, necessary repairs shall be made with a water reactive elastomeric chemical grout, such as 3M Scotch Seal Chemical Grout 5600, or a water reactive polymer solution, such as Avanti AV-202, or equivalent. Resealing and retesting shall be performed until the manhole passes the test.

3503 ACCEPTABLE MANUFACTURERS AND MODELS

A. General: A list of acceptable manufacturers and models for various materials will be maintained by the City Engineer and updated on a regular basis. An approved list of materials can be found on the City's web site www.cityofls.net. Go to Development, then Development Regulations, then Design and Construction Manual.

SECTION 3900 - WATER MAINS

CITY OF LEE'S SUMMIT, MISSOURI
STANDARD SPECIFICATIONS

3901 MATERIALS

A. General: All materials shall comply with the latest revision of the reference standard applying to that particular material. All pipes, fittings and appurtenances containing more than 0.25 percent lead calculated by weighted average shall not be used except materials in brass service saddles and fire hydrants.

B. Pipe and Fittings for Water Mains

1. Allowable Materials: Pipe and fitting materials used in the construction of water mains shall be:

   a. Ductile Iron (DI), with a minimum wall thickness of special thickness Class 50
   b. Polyvinyl chloride (PVC), AWWA C900
   c. Fusible Polyvinyl chloride (PVC), Fusible AWWA C900

2. Requirements: The pipe manufacturer shall furnish pipe of materials, joint types, sizes, and strength classes indicated and specified. The Contractor shall furnish maximum pipe lengths normally produced by the manufacturer except for fittings, closures, and specials.

3. Manufacturer's Experience: The Manufacturer shall be experienced in the design, manufacture, and commercial supplying of the specified material.

4. Inspection and Testing: Inspection and testing shall be performed by the Manufacturer's quality control personnel in a manner complying with applicable standards.

5. Markings: Each pipe or fitting shall have the following information plainly and permanently marked by indenting in the outside surface of the pipe or painted thereon with waterproof paint:

   a. Pipe size and class or designation.
   b. Date manufactured and lot number.
   c. Manufacturer's name or trademark.
   d. For ductile iron pipe, in lieu of the above listed markings, the information may be provided on an adhesive bar code labeling system that complies with AWWA Standards. The adhesive label shall be provided on the outside surface near the bell.

6. Handling: The Manufacturer and Contractor/Developer shall use equipment and methods adequate to protect the pipe and joint elements and to prevent shock contact of adjacent units during moving or storage. Damaged sections that cause reasonable doubt as to their structural strength or water-tightness will be rejected.

7. On-Site Inspection: All pipe and appurtenances will be inspected by the Inspector prior to installation, and all damaged pieces as well as any pieces not complying with the City of Lee's Summit Standard Specifications shall be immediately removed from the job site and replaced by pipe and appurtenances as may be acceptable to the Inspector at the expense of the Contractor/Developer.

8. Certification: Suppliers shall submit certifications with their material delivery. These certifications shall be given to the Inspector.

C. Ductile Iron Pipe and Fittings

1. Design: All DI pipe (DIP) shall comply with ANSI/AWWA C150/A21.50 and ANSI/AWWA C151/A21.51. The minimum thickness shall be Special Thickness Class 50.

2. Fittings:

   a. All DI fittings shall comply with ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53 and shall have a pressure rating of 350 psi for fittings less than 30 inches in diameter and 250 psi for fittings greater than or equal to 30 inches in diameter.

   b. All DI fittings shall have the pressure rating and the letters "DI" or "DUCTILE" distinctly cast into the outside surface.

3. Joints: Mechanical and push-on joints for pipe and fittings shall comply with ANSI/AWWA C111/A21.11. Natural rubber gaskets shall not be accepted.

4. Restrained Joint Pipe and Fittings:

   a. Restrained joint pipe and fittings shall be per the pipe manufacturer's recommendation. American Flex-Ring, US Pipe TR Flex, US Pipe Mech-Lok, US Pipe Bolt-Lok and McWane TR Flex are considered restrained joints.

   b. Retainer glands (e.g., Megalug, Uni-Flange, etc.), and gripper gaskets (e.g., Field-Lok, Fast-Grip, etc.) are not considered a permanent restraint and must be used in conjunction with straddle or thrust blocks.

5. Coatings:

   a. The pipe exterior shall be coated with a layer of arc-sprayed zinc per ISO 8179 with a mass of 200 g/m^2. Pipe markings shall include the word "ZINC". The zinc shall be covered with a standard thickness exterior bituminous coating complying with ANSI/AWWA C151/A21.51.

   b. The interior and exterior of fittings shall be furnished with a fusion-bonded epoxy coating complying with ANSI/AWWA C116/A21.16.

c. All glands and retainer glands shall be coated with one of the following coatings:

i. A fusion-bonded epoxy coating complying with ANSI/AWWA C116/A21.16.

ii. A polyester coating applied by an electrostatic spray process and heat cured.

iii. A Corrsafe coating as manufactured by the Sigma Corporation.

6. Linings: Pipe shall have a standard thickness cement mortar interior lining complying with ANSI/AWWA C104/A21.4. A seal coat shall be provided over the cement mortar lining.

a. The seal coat may be subjected to an adherence test using 3M Tartan Duct Tape 3939. Pipe will be rejected if the seal coat is removed down to the cement mortar lining by the duct tape.

7. Polyethylene Encasement: All DIP and DI fittings shall be installed with a polyethylene tube encasement that is a co-extruded 3 layer film enhanced with a corrosion inhibitor and a biocide complying with AWWA/ANSI C105/A21 with a minimum thickness of 0.08 inches (8 mils).

a. The ends of the polyethylene encasement and joints shall be thoroughly sealed with adhesive tape. Where polyethylene wrapped pipe or fittings being installed connect to a pipe that is not wrapped (including existing pipe), extend the wrap a minimum of 3 feet onto the previously uncovered pipe. This includes service lines which may be wrapped in polyethylene or dielectric tape.

b. Adhesive tape shall be a general purpose adhesive tape 2-inches wide, plastic backed, and capable of bonding securely to metal surfaces and/or polyethylene material. Tape shall be Polyken No. 900, Scotch Tape No. 50, Tapecoat CT or approved equal. Duct tape will not be allowed.

8. Bolts: Bolts shall comply with ANSI/AWWA C111/A21.11. All bolts shall be coated with FluoroKote #1 or approved equal. After field installation, all bolts shall be coated with an aerosol applied rubberized coating. The material shall be rapid dry and specifically designed for corrosion protection. 3M Rubberized Underseal Undercoating 08883 or any equivalent rubberized-bitumen based spray-on undercoating may be used.

D. Polyvinyl Chloride Pipe and Fittings

1. Design: All PVC pipe shall comply with ANSI/AWWA C900. The minimum pressure class shall be Pressure Class 235.

2. Fittings: Where fittings are required, they shall be ductile iron and comply with Paragraph 3901.C.2.

3. Joints: Joints for pipe and fittings shall comply with ANSI/AWWA C900.

4. Restrained Joint Pipe and Fittings:

    a. Restrained joint pipe and fittings shall be per the pipe manufacturer's recommendation. Fused and Certa-Lok are considered restrained joints.

    b. Retainer glands (e.g., Megalug, Uni-Flange, etc.), and gripper gaskets (e.g., Field-Lok, Fast-Grip, etc.) are not considered a permanent restraint and must be used in conjunction with straddle or thrust blocks.

5. Polyethylene Encasement: See Section 3901.C.7 for polyethylene encasement of DI fittings.

E. Concrete: Concrete shall be a shall be a MoDOT Class B-1 Air Entrained mix or KCMMB 4k mix, unless otherwise shown on plans.

F. Granular Bedding Aggregate Material: See Section 2100.

G. Backfill: See Section 2100.

H. Flowable Backfill: Flowable backfill shall consist of Controlled Low Strength Material (CLSM) complying with the requirements in Section 2100.

I. Trench Checks: Trench checks shall consist of flowable backfill as specified in Paragraph 3901.H.

J. Utility Markers:

1. Utility marker tape shall be minimum 2 inches wide, 4-mil thick blue plastic tape with the word "WATER" lettered in permanent black graphics.

2. In addition to utility marker tape, a PVC water main shall have a tracer wire installed along the top of the pipe. Tracer wire installed using open trench installation shall be #12 AWG copper clad steel with a minimum 30 mil HDPE insulation thickness. Tracer wire shall be detectable using either the inductive or conductive modes using a pipe and cable locator.

3. Splices in wiring shall be made with a locking splice connector manufactured with a waterproof dielectric sealant. Refer to the Water Utilities Approved Product List.

K. Thrust and Straddle Blocks: Concrete used for thrust and straddle blocks shall be a shall be a MoDOT Class B-1 Air Entrained mix or KCMMB 4k mix.

L. Pipe Encasement: Concrete used for pipe encasement shall be shall be a MoDOT Class B-1 Air Entrained mix or KCMMB 4k mix.

M. Valves

1. General:

a. All valves shall be certified as suitable for contact with drinking water by an accredited certification organization complying with ANSI/NSF Standard 61, Drinking Water Systems Components–Health Effects.

b. All valves shall have a 2-inch square nut operator.

c. Direction to open shall be counterclockwise and be marked as such.

d. Valves on the existing water system or valves that separate newly constructed mains from the existing water system shall be operated by City staff. The Water Utilities Supervisor shall be notified prior to operating any valves.

2. Butterfly Valves

a. Design: All butterfly valves shall comply with ANSI/AWWA C504 for Class 150B service, as modified herein.

b. Testing: Each valve shall be factory tested per AWWA C504. Valves shall be subjected to and pass a one-time pressure test of 200 psi prior to delivery. Valves shall be clearly marked to that effect, and if the Drawings call for valves that have been subjected to and passed a one-time pressure test of 192.5 psi prior to delivery (for those areas of the City where the line pressure exceeds 100 psi), those valves shall be clearly marked to that effect. The manufacturer shall provide for testing certification, which shall be given to the Inspector upon delivery of the valves to the site.

c. Bolts: Bolts shall comply with ANSI/AWWA C111/A21.11. All bolts shall be coated with FluoroKote #1 or approved equal. After field installation, all bolts shall be coated with an aerosol applied rubberized coating. The material shall be rapid dry and specifically designed for corrosion protection. 3M Rubberized Underseal Undercoating 08883 or any equivalent rubberized-bitumen based spray-on undercoating may be used.

d. Refer to the Water Utilities Approved Products List.

3. Gate Valves

a. Design: All gate valves shall comply with ANSI/AWWA C509 or AWWA C515 for resilient-seated gate valves, as modified herein. Gate valves shall be designed for underground direct burial service. The minimum design working water pressure shall be 200 psig. All internal parts shall be accessible without removing the body from the water main.

b. Body: Valve bodies shall be constructed of cast iron (ASTM A 126, Class B) or DI (ASTM A 536) complying with AWWA C509 or AWWA C515 in terms of minimum body shell thickness. Valve ends shall be mechanical joint or flanged as shown on the Drawings and shall comply with AWWA C509 or AWWA C515.

c. Gate/Wedge: The valve gate or wedge shall be fully encapsulated with rubber to create a resilient seat.

d. Stem: Valve stem shall be non-rising and made of bronze complying with ASTM B 138 or manganese bronze complying with ASTM B 584. Stem seals shall be the O-ring type, not flat gaskets.

e. Coatings: Coating shall be non-toxic and impart no taste to water. All internal and external surfaces shall be covered with a fusion bonded epoxy coating complying with AWWA C550. Although the AWWA standard only refers to interior coatings, the external epoxy coating shall be applied in a manner similar to that used for application of the interior coating. Coating shall be applied prior to assembly such that all exposed external areas—including end connection bolt holes, body-to-bonnet bolt holes, etc.—shall be coated with epoxy.

f. Bolts: Bolts shall comply with ANSI/AWWA C111/A21.11. All bolts shall be coated with FluoroKote #1 or approved equal. After field installation, all bolts shall be coated with an aerosol applied rubberized coating. The material shall be rapid dry and specifically designed for corrosion protection. 3M Rubberized Underseal Undercoating 08883 or any equivalent rubberized-bitumen based spray-on undercoating may be used.

g. Testing: Each valve shall be factory tested per AWWA C509 or AWWA C515.

h. Refer to the Water Utilities Approved Products List.

4. Air Release Valves

Refer to the Water Utilities Approved Products List.

N. Tapping Sleeves

1. The use of a tapping sleeve and valve is to be minimized and will only be allowed on a case-by-case basis.

2. Design Engineer shall provide justification when proposing the use of a tapping sleeve and valve.

O. Valve Boxes

1. Valve Box Covers: All valve box covers, whether in pavement or grassed areas, shall meet the following requirements:

a. Cast iron castings shall conform to the requirements of "Gray Iron Castings," ASTM A48/AASHTO M105, Class 30B.

b. Dimension Tolerances:

i. The dimensions of all castings shall be ± 1/8 inch of the dimensions shown in the Standard Drawings.

ii. Each casting shall weigh at least 95 percent of the weight for its specific type as stated by the manufacturer.

c. Workmanship and Finish:

i. Castings shall be free of casting defects such as porosity, rough surfaces and shrinkage.

ii. Surfaces shall be free of fused on sand and shall be smooth.

iii. Runners, risers, fins and other cast-on pieces shall be removed.

d. Interchangeability: Castings shall be interchangeable with the Clay & Bailey Model 2195 valve box lids.

e. Markings:

i. Imported castings shall meet the country-of-origin markings as required in accordance with Title 19, Code of Federal Regulations, Part 134 (19 CFR 134).

ii. The word "WATER" shall appear on the cover as shown on the standard details.

2. Valve Boxes:

a. Valve boxes shall be made of C900 pipe. Refer to Water Utilities Approved Products List.

b. Valve box shall be cut to finish grade after final site grading is complete. Buried valve boxes shall be uncovered and extended by the Contractor/Developer prior to final acceptance of the Work by the City.

3. All valves with the operating nut greater than 3 feet below finished grade or road surface shall be provided with extension stems to bring the operating nut to within 3 feet of the finished grade. Stem guides shall be provided to keep the valve stem extensions concentric with the valve box.

4. All ferrous metal parts shall be painted with an asphalt varnish.

P. Backflow Prevention Devices

1. The current MDNR Approved Backflow Prevention Assemblies list shall be used to select the BFPD.

2. Vaults:

a. Vaults shall be made of at least a MoDOT Class B-1 Air Entrained concrete mix or KCMMB 4k concrete mix. Other materials may be used if approved by the City Engineer.

b. Steps meeting the requirements for manhole steps (see Paragraph 3500.P.8. of the City of Lee's Summit Standard Specifications) shall be cast into the vault wall in-line with the top opening.

c. Minimum clearance dimensions shall be as shown in the Standard Drawings.

3. Irrigation Box: Backflow prevention devices shall be installed horizontally.

Q. Fire Hydrants

1. All fire hydrants shall be the traffic model, break-away type, and comply with the current AWWA C502.

2. Hydrants shall have a minimum design working pressure of 150 psig and test pressure of 300 psig.

3. Hydrants shall have two 2½-inch nozzles and one 4½-inch pumper nozzle with national standard fire hose coupling screw thread. Nozzle caps shall be the "nut type" having the same dimensions as the operating nut. Such caps shall be securely chained to the base of the hydrant.

4. The size of the hydrant main opening shall be 5¼ inches.

5. Operating nut shall be 5-sided measuring 1½" from point to flat and include the weather shield.

6. Hydrant shall be furnished with a 6-inch isolation gate valve in accordance with Paragraph 3901.M.3 of the City of Lee's Summit Standard Specifications.

7. Direction to open shall be counterclockwise and be marked as such.

8. Hydrants shall come with an oil reservoir or grease zerk.

9. Hydrant shoes shall be coated in fusion bonded epoxy.

10. Hydrants shall be factory painted (baked on enamel) according to the following schedule:

Ownership	Color
City	Optic yellow
Private	Optic yellow with silver bonnet
Private–Yard fire hydrant (i.e., attached to the fire suppression system)	Red

11. Extension Kits

a. Extension kits shall be supplied by the hydrant manufacturer.

b. All extensions shall be factory painted (baked on enamel) and shall match the color of the barrel section as called for in Paragraph 3901.Q.9. above.

12. Hydrants shall be furnished with temporary black plastic caps or shall be covered with black plastic bags until the hydrants are available for service.

13. Refer to the Water Utilities Approved Products List.

R. Service Lines from the Water Main to the Water Meter: Service lines 2 inches in diameter and smaller shall be made of Type K soft copper, complying with ASTM B 88. Connections to service lines less than 2 inches in diameter shall be flared. Connections to 2-inch service lines shall be pack joint or A.Y. McDonald CTS Compression. Service lines greater than 2 inches in diameter shall be DIP or PVC pipe and shall comply with Paragraphs 3901.C. or 3901.D, respectively, of the City of Lee's Summit Standard Specifications, subject to restrictions based on the City's currently-adopted Fire Code.

S. Casing Pipe

1. Pipe

a. The casing pipe shall be made of steel complying with ASTM A 139, grade B, with a minimum yield strength of 35,000 psi.

b. The minimum wall thicknesses required are shown in the following table:

Casing Diameter (inch)	Minimum Wall Thickness
10, 12, 14, 16	0.188" (3/16")
18, 20, 22	0.250" (1/4")
24, 26	0.281" (9/32")
28, 30, 32, 34	0.312" (5/16")
36, 38, 40, 48	0.344" (11/32")

2. Spacers: Casing spacer shall be a two-piece shell or band made from T-304 stainless steel of a minimum 14-gauge thickness. The shell/band shall have risers made of 10-gauge T-304 stainless steel and have a PVC liner. The bearing surface (skid or runner) shall be made of an ultra-high molecular weight polymer, glass reinforced polyester, or fiberglass reinforced nylon. The shell/band shall be bolted together with T-304 stainless steel bolts. The configuration of the carrier pipe in the casing pipe shall be centered. End seals shall be made by the same manufacturer as the casing spacers and shall use stainless steel bands to hold end seals to pipes.

3. Ends of the Casing Pipe: The ends of the casing pipe shall be closed with a manufactured end seal (see the Standard Drawings)

3902 CONSTRUCTION AND INSTALLATION

A. General

1. Notification

    a. Disruption of Water Service:

        i. When a disruption of water service will occur, the Contractor shall notify Water Utilities Operations at least 48 hours in advance to make the necessary arrangements.

        ii. It shall be the Contractor's responsibility to place door hangers on the affected premises at least 24 hours in advance of the disruption. The door hanger shall indicate the date and time of the disruption and its anticipated length.

        iii. Once the work begins, the work shall be continuous (24 hours per day) until completed.

    b. The Contractor's work shall be scheduled in a manner to accommodate the schedules of the City and the affected customers.

        i. In the event closing of valves to make a connection will affect a customer who cannot be without service, as approved by the City Engineer, the Contractor shall make provisions to provide temporary service to that customer.

        ii. In the event closing of valves to make a connection will affect a customer who can temporarily be without service, the maximum amount of time the customer may be without service, without Contractor furnished provisions for temporary service, shall be 8 hours.

2. Protection of Existing Water Mains, Sewers, Structures, or Utilities

    a. Where new lines approach, cross, connect to, or run parallel to existing water or sewer mains, the Contractor shall be held completely responsible for protecting, preserving, and otherwise maintaining existing line during construction of new line. Any damage inflicted to water and sanitary sewer mains or structures must be promptly reported to Water Utilities Operations and arrangement made for the repair. Any damage inflicted to storm sewer lines or structures must be reported promptly to the Public Works Operations Division and arrangement made for repair. Any damage inflicted to any other utility must be reported promptly to the respective utility and arrangement made for the repair.

    b. The Contractor shall protect all existing structures, utilities, and work of any kind against damage or interruption of service that may result from the operations of the Contractor. Damage or interruption of service resulting from failure to do so shall be repaired or restored promptly at the expense of the Contractor.

    c. The Contractor shall give reasonable notice to utility companies and to other owners of property when such property is liable to damage or injury could result from the execution of the Work, so that the owners of such utility or property may take precautionary measures.

d. The Contractor shall be responsible to adjust to finish grade any existing utility/appurtenances (i.e. valves, meter wells, sanitary sewer manhole, storm junction box etc.) that is affected by construction.

3. Handling and Storage

a. Handle pipe materials and fittings in a manner to assure installation in sound and undamaged condition. Use slings, lifting bags, hooks, and other devices designed to protect pipe, joint elements, and coatings. In handling plastic pipe of 10 feet or more long, a double sling will be required.

b. Ship, move, and store with provisions to prevent movement or shock contact with adjacent units.

c. Pipe shall be handled in a manner that minimizes the damage to the coating. Damaged coating shall be repaired in a manner complying with the pipe manufacturer's recommendations.

4. Inspection of Materials: All pipe, fittings, and accessories shall be examined by the Inspector prior to installation for soundness and specification compliance. Rejected materials shall be marked and removed from the project site, and replaced with approved materials.

5. Alignment: Pipe shall be laid to the lines and grades as shown on the approved Engineering Plans.

6. Cleaning: All pipe, fittings, and accessories shall be kept clean of foreign matter while being handled or stored. During installation, foreign matter shall not enter the pipe or appurtenances. At the end of each working day, a temporary plug shall be installed at the termination of the pipeline.

B. Water Main Installation

1. Installation Standards: All pipes shall be installed in a manner complying with the following standards:

a. DIP - ANSI/AWWA C600.
b. PVC Pipe - ANSI/AWWA C605.

2. Installation

a. Governmental Requirements: Water main installation shall comply with applicable local, State, and Federal requirements.

b. Trench Dewatering: See Section 2100.

c. Drainage Course Crossings: See Section 2100.

d. Trench Widths

i. Minimum Widths: Trench widths pipe clearances shall be not less than those shown in the following table.

TRENCH WIDTHS AND PIPE CLEARANCES (in)			
Nominal Pipe Diameter	Suggested Trench Width[1]	Minimum Pipe Side Clearance[2] (Soil/Rock)	Minimum Pipe Bottom Clearance (Soil/Rock)
6	30	6/6	6/6
8	32	6/6	6/6
10	34	6/6	6/6
12	36	6/6	6/6
16	40	6/6	6/6
18	42	6/6	6/6
20	44	7/9	6/9
24	48	7/9	6/9
30	54	8/9	6/9

[1] Measured at the top of the pipeline.

[2] Measured from the outside face of pipe barrel to inside face of trench.

ii. Maximum Widths: Maximum trench widths shall be governed by existing soils, trench type, bedding, and laying conditions. Maximum widths shall not exceed the manufacturer's recommendations.

iii. Trench Slope: See Section 2100.

iv. Trench Shields: See Section 2100.

e. Compacted Fill: See Section 2100.

f. Pipe Embedment: DIP and PVC pipe shall be bedded in bedding material with a minimum thickness beneath the pipe as specified in Paragraph 3902.B.2.d. Also see Section 2100.

g. Bedding Installation: See Section 2100.

3. Backfill: See Section 2100.

4. Utility Marker Tape and Tracer Wire: Install utility marker tape above the centerline of each water main. Bury marker tape 18 to 24 inches below finished grade, along the full length of the water main. When tracer wire is required, tracer wire shall be installed along the top of the pipe so that the wire is in relatively continuous contact with the pipe. All tracer wires shall be interconnected at intersections, at tees and crosses using splice kits. The wire shall be accessible at every valve box including valve boxes on fire hydrant isolation valves. The Contractor shall connect new tracer

wire to existing tracer wire at tie-in locations where there is existing tracer wire. At tie-in locations where there is no existing tracer wire and no proposed valve to be installed, the Contractor shall terminate the tracer wire with a 1.5-pound magnesium ground rod with a minimum 20 feet of #12 AWG copper clad steel wire with 30 mils of HDPE insulation. Marker tape and tracer wire shall be inspected by the City Inspector prior to backfill. All new tracer wire installations shall be located using low frequency (512 Hz) line tracing equipment, and witnessed by the Contractor and the Owner prior to final acceptance of the project. Any tracer wire broken during installation shall be repaired by the Contractor. All tracer wires shall be tested after all other acceptance tests have passed.

5. Domestic Service Connections

    a. The City will install a corporation connection at the main for individual, commercial, industrial, and residential service lines that are 2 inches in diameter and less. The Contractor/Developer shall notify Water Utilities Operations 48 hours in advance of requiring a service connection.

    b. Taps: Refer to the Water Utilities Approved Products List.

        i. A saddle shall be required when PVC pipe is tapped

        ii. A direct tap with a tapping machine is required for DIP.

    c. For service lines larger than 2 inches in diameter, a tee shall be cut in with appropriate valving or a tapping sleeve and valve shall be installed. The Contractor/Developer shall notify Water Utilities Operations and the Inspector 48 hours prior to starting this work.

    d. Excavation for service connections shall be provided by the Contractor/Developer as illustrated in the Standard Drawings. The excavation shall be prepared prior to the time scheduled with Water Utilities Operations for the tap.

    e. Installation of meters greater than 2-inch diameter will be specifically approved by the City Engineer.

    f. Excavation shall be adequately protected in accordance with Section 2103 of Lee's Summit Special Provisions. Backfilling shall take place as soon as practicable.

6. Thrust Restraint

    a. All plugs, caps, dead ends, tees, bends and hydrants shall be provided with thrust blocks as shown in the Standard Drawings.

    b. Concrete construction shall comply with ACI 301, Specifications for Structural Concrete.

c. Concrete shall extend from fitting to undisturbed soil and shall be installed so that all joints are accessible.

d. Concrete shall be placed and cured for 24 hours prior to energizing the water main.

e. If adequate soil support cannot be obtained, a mechanical restraining assembly shall be installed as approved by the City Engineer.

7. Pipe Encasement, Straddle Blocks, and Trench Checks

   a. Total or partial encasement of pipe in concrete shall be used where the required safe supporting strength of the pipe cannot be obtained by other bedding methods. Concrete encasement shall also be provided at locations where there exists the possibility that standard bedding may be eroded by currents of water under and around the pipe. Concrete construction shall comply with ACI 301, Specifications for Structural Concrete.

   b. Concrete encasement shall be constructed at locations indicated and complying with details as shown on the Engineering Plans and in the Standard Drawings. Start and terminate encasement at a pipe joint. Adequately support and block the pipe to maintain position and prevent flotation. Form to dimensions indicated or construct full width of the trench.

      i. Longitudinal reinforcement shall be continuous.

      ii. Concrete encasement shall be protected and cured so as to prevent excessive evaporation of moisture or freezing. Backfilling will not be considered as a suitable method of curing the encasement.

      iii. Backfill trench only after concrete encasement has obtained a minimum of 2000 psi. All backfilling shall be done in accordance with Section 2100.

   c. Straddle blocks shall be constructed at locations indicated on and comply with details shown on the Engineering Plans and in the Standard Drawings.

   d. Trench Checks: Trench checks shall be located as shown on the plans. They shall consist of flowable backfill and extend 12 inches below the bottom of the pipe. Length shall be a minimum of 12 inches and width shall be the width of the trench. The height of the trench check shall extend to 12 inches above the top of the pipe.

8. Pipe Laying: All pipe installation shall comply with the pipe manufacturer's recommendations, except as modified herein.

   a. Pipe laying shall not proceed if the trench width as measured at the top of pipe exceeds the maximum allowable trench width. If this occurs, the Contractor shall submit to the Design Engineer and the City Engineer, for approval, a better bedding design for the pipe or pipe of sufficient strength to provide safe supporting strength.

b. All pipe and fittings shall be stored and handled with care to prevent damage thereto. Do not use hooks to transport or handle pipe or fittings. Do not drop pipe or fittings.

c. Pipe and fittings rejected by the Inspector shall be marked and removed from the project site. All pipe and fittings shall be examined for soundness and specification compliance prior to placement in the trench and rejected pipe or fittings shall not be incorporated into the pipeline. Check the class or pipe strength to be sure proper pipe is installed.

d. Clean joint contact surfaces prior to jointing. Use lubricants, primers, or adhesives as recommended by the pipe or joint manufacturer. Keep lubricants and applicators clean.

e. Excavate bell holes for each pipe joint. When jointed, the pipe shall form a true and smooth pipeline.

f. The alignment of all pipelines shall be true to line and grade. The pipe shall be truly centered into the abutting pipe.

g. On transmission mains, the pipes and appurtenances shall be truly laid to line and grade throughout, all junctions and other pieces required shall be properly excavated for and laid as shown on the Drawings, and the following tolerances from true horizontal alignment and vertical grade shall be maintained:

Horizontal Alignment:	$\pm$12 inches
Vertical Grade:	$\pm$ 0.1 feet

Pipe installed but not meeting these tolerances shall be ordered removed and replaced at the Contractor's expense.

h. The trench shall be excavated to sufficient depth to allow embedment to be placed in the bottom of all trenches. At the pipe joints, the trench shall be excavated to an additional depth so that the bell will not rest on the bottom of the trench, and all the weight of the pipe shall be evenly distributed along the entire length of the barrel of the pipe.

i. The water main must be made watertight at all points; any leaks or other defects discovered at any time before the final acceptance of the Work shall be immediately repaired or that portion of the water main shall be rebuilt if necessary.

j. In all cases, full length sticks of pipe shall be used, except in making closures.

k. Clean interior of all pipe, fittings, and joints prior to installation. To exclude entrance of foreign matter during discontinuance of installation, close open ends of pipe with snug fitting closures. Take reasonable precautions to not let water fill the open trench, and include provisions to prevent pipe flotation. Remove water, sand,

mud, and other undesirable backfill materials from trench before removal of end cap.

l. In forming joints, each length of pipe shall be carefully aligned in such manner as to form an accurate concentric joint, thus providing a uniform circular pipe opening. Each length of pipe shall thrust into the bell and shall be securely held in position until the next length of pipe has been placed.

m. The pipeline trench excavation shall be dewatered sufficiently to allow pipe joints to be made under dry conditions. No joints shall be made under water.

n. Joints:

   i. Joints shall in general be made complying with the manufacturer's recommendations and as specified herein.

   ii. Clean and lubricate all joint and gasket surfaces with lubricant recommended by pipe manufacturer.

   iii. Care shall be exercised by the Contractor to insure against damage to joint material in storage, handling, or placing operations.

   iv. No damaged joint material shall be permitted to be used and the same shall be removed from the job site.

   v. All pipe joints shall be completed by insuring that the ends of the pipe to be joined are in contact and completely shoved into "home" position.

o. Pipe shall be cut in a neat workmanlike manner without damage to pipe. Cutting of pipe with a torch is not permitted. Smooth cut by power grinding to remove burrs and sharp edges. Repair the lining as required and approved by the Inspector.

p. All pipelines shall be plugged at the end of each day's progress. Plugs or other positive methods of sealing shall be utilized at all times to protect any existing system from entrance of stormwater or other foreign matter.

q. Crossings:

   i. Water mains crossing sanitary or storm sewers shall be installed providing a minimum vertical clear distance of 18 inches between the outside of the water main and the outside of any sanitary sewer and storm sewer. This shall be the case where the water main is either above or below the sewer.

   ii. At crossings, a full length of water pipe shall be located such that both joints will be as far from the sewer as possible.

   iii. Where conditions prevent the minimum vertical separation set forth above from being maintained, the following shall be applied:

- The water main shall be constructed of mechanical or manufactured restrained joint pipe, fusion welded pipe, or cased in a continuous casing that extends no less than ten feet on both sides of the crossing. Casing pipe must be a material that is approved for use as water main.

- Any exception from the minimum vertical clear distance must be submitted to the Missouri Department of Natural Resources for approval.

iv. Provide special structural support for the pipes as necessary.

v. Minimum crossing angle shall be 45 degrees.

9. Valves, Fittings, and Hydrants:

   a. Valves, fittings, and hydrants shall be set and jointed to a new pipe in the manner specified for cleaning, laying, and jointing pipe.

   b. Valves, fittings, hydrants, and pipe shall be supported in such a manner that there is no deflection in the valve or fitting-to-pipe joint. Larger valves and fittings may require additional support so that the pipe does not have to support the weight of the valve or fitting. In no case shall hollow pipe be used as a support mechanism.

   c. Valve boxes and lids shall be installed over each valve. The valve box shall be supported in a manner to remain centered and plumb over the operating nut of the valve. The valve box shaft shall not transmit shock or stress to the valve. Valve box covers shall be installed flush with the finish grade, or as directed by the Inspector.

   d. Hydrants:

      i. Hydrants shall be installed as shown in the Standard Drawings.

      ii. Hydrants shall be installed so that the steamer nozzle is 18 inches above final grade, and the bottom of the break-away coupling is 2 to 6 inches above final grade, as recommended by the hydrant's manufacturer.

      iii. Hydrants shall stand plumb.

      iv. The weep holes of the hydrant shall be kept clear and free to drain.

      v. Refer to AWWA Manual M17 for additional installation guidelines.

10. Removal of Water: The Contractor shall provide dewatering as specified in Section 2103. Damaged pipe or structures of any kind resulting from insufficient dewatering facilities or similar lack of proper conduct of the work shall be replaced by the Contractor at their own expense. No structure or pipes shall be laid in water, and no water shall be allowed to run into or over any concrete work or pipe, or into or through any pipe.

11. Water Main Connections to Existing Main

    a. The Contractor/Developer shall furnish and install all of the fittings necessary for connections between new water mains and existing water mains. The use of tapping sleeves and valves is to be minimized and shall only be allowed where required on approved engineering drawings. The installation of tapping sleeves and valves shall be done while an Inspector is present.

        i. All tapping sleeves will be required to meet the following air test:

            - < 12-inch, hold 45 psi for 1 minute
            - ≥ 12-inch, hold 60 psi for 1 minute

        ii. Tapping into existing mains shall be done with no interruption of existing services unless otherwise approved by the City Engineer 48 hours prior to disruption of service.

    b. Valves on the existing water system or valves that separate newly constructed mains from the existing water system shall be operated by City staff. The Water Utilities Supervisor shall be notified prior to operating any valves.

    c. Special care should be taken when making a connection to an existing main. No foreign material or contaminants will be permitted to enter the water system.

    d. Thrust blocks shall be provided at the new connection to provide thrust restraint as shown in the Standard Drawings

12. Abandonment of Water Mains

    a. No existing water mains shall be abandoned prior to contacting Water Utilities Operations at least 48 hours in advance.

    b. Prior to abandonment of a water main, the Contractor shall verify that no existing services will be affected.

    c. If a water main is indicated for abandonment, it shall be abandoned by removal and backfill if required or by plugging each end of the line segment. To plug each end of the line segment, a section of pipe at least 10 feet long shall be cut out of the existing line. The water shall be drained out to the fullest extent practicable, and the ends shall be sealed with a 1-foot thick plug of non-shrink grout sealed with a Portland cement grout.

    d. Location of cut line and plugs shall be shown on the record drawings.

    e. Hydrants (complete) shall be removed and returned to Water Utilities Operations.

13. Abandonment of Service Lines

a. Water service lines shall be disconnected from the water main when buildings are demolished and there are no re-development plans to reuse the existing tap.

b. If the water service line is to be reused it shall be compliant with all applicable codes and standards in effect at the time.

c. Water service lines being disconnected from the water main, shall be disconnected by the Water Utilities Department after the contractor has provided access to the main via an OSHA compliant excavation with proper shoring as necessary. Water Utilities staff reserve the right to not enter any trench determined to be unsafe

d. The water meter on abandoned service lines shall be removed by the Water Utilities Department.

14. Protection of Water Supplies

a. There shall be no physical connection between a public or private potable water supply system and a sewer, or an appurtenance thereto, that would permit the passage of any wastewater or polluted water into the potable water supply.

b. For water mains paralleling or crossing sewer mains, see Paragraph 6901.D.1.c.

c. Water and sewer mains shall not be placed in the same trench or excavation.

15. Connection of Pipes of Dissimilar Materials: The connection of pipes of different materials shall be made using approved transition couplings, and shall provide a permanent and watertight connection that will withstand the hydrostatic test pressure.

C. Disinfection

1. General

a. Precautions, methods, procedures and materials for disinfection shall comply with the current AWWA C651.

b. Precaution shall be taken to protect the interior of pipes, fittings, and valves against contamination. Pipe shall be handled in such a manner to prevent the entrance of foreign material or water.

c. All water mains shall be disinfected and tested. Not more than 4,000 feet of water main shall be installed without disinfecting and testing.

d. The Contractor/Developer shall notify the Inspector at least 48 hours prior to commencing disinfection.

e. Existing water distribution system valves shall be operated by City staff.

f. Samples shall be taken at locations selected by the Inspector but not less than 1 sample shall be collected for every 1,200 feet of pipe, plus 1 sample from each

dead end line, and at least 1 set from each branch. If trench water has entered the main, samples shall be collected every 200 feet.

g. If the continuous feed method of chlorination is selected, bacteriological samples shall not be taken until the water mains have passed hydrostatic and leakage tests.

2. Filling: After installation, the entire main shall be completely filled with water to eliminate air and be flushed to remove any material that may have entered the main. Flushing velocities shall not be less than 3.0 feet per second.

   a. If the continuous feed method of chlorination is selected, the filling and flushing shall be done prior to chlorination.

   b. If the tablet method of chlorination is selected, the filling shall be done very slowly (i.e., less than 1 ft/s) and in the presence of the Inspector. The water main shall be flushed after it has been chlorinated.

3. Chlorination: Chlorination shall comply with the procedures given in AWWA C651, as modified below.

   a. The tablet method may only be used under the following conditions:

      i. The water main to be chlorinated is 12 inches in diameter or less,
      ii. Calcium hypochlorite granules are used (i.e., not tablets), and
      iii. The pipes and appurtenances are kept clean and dry during construction.

   b. The tablet method shall not be used if nonpotable water or foreign materials have entered the mains or if the water temperature is below 5°C (41°F).

   c. The slug method may only be used with prior permission from the City Engineer.

   d. Cutting into or Repairing Existing Water Mains:

      i. Disinfection procedures when cutting into or repairing existing water mains shall comply with AWWA C651.

      ii. This procedure shall only be used if the length of pipe to be disinfected is less than 150 feet, unless otherwise approved by the City Engineer.

   e. A basic flow chart for the chlorination process is given in Figure 3901-1 and is further described below.

      i. Chlorinate water main and measure chlorine at the ends of the water main and ends of all branches. A minimum of 25 milligrams per liter (mg/l) free chlorine should be detected at each location, or additional chlorination is required until that level is reached.

      ii. When acceptable chlorine levels are detected at all points, the Contractor/Developer shall operate all valves and hydrants within the newly-constructed

section (except for the valve tying the new construction to the City's distribution system) in order to disinfect appurtenances.

iii. The chlorinated water shall be retained in the water main for at least 24 hours.

iv. If the required minimum residual of 10 mg/l chlorine is not present in all portions of the water main after 24 hours, rechlorinate the water main.

v. If the required minimum residual of 10 mg/l chlorine is present in all portions of the water main, flush the water main until chlorine measurements show the water leaving the test main are no higher than that prevailing in the system.

vi. Disposal of Heavily-Chlorinated Water: The heavily-chlorinated flush water shall be discharged to a sanitary sewer, or the flush water shall be dechlorinated in a manner complying with AWWA C651, Appendix C. If the flush water is to be discharged to the sanitary sewer, the Contractor/Developer will be charged for the disposal of the quantity of water disposed.

vii. Samples shall be taken of water that has stood in the main for at least 16 hours after final flushing has been completed and shall be tested by a state-certified laboratory, as approved by the City, for bacteriological quality complying with "Standard Methods for the Examination of Water and Wastewater." The samples shall meet the MDNR standard.

viii. Samples for bacteriological testing shall be taken through a corporation stop and copper tubing.

ix. The first set of bacteriological samples will be taken under the direction of the Inspector, who will take this and all subsequent samples to the laboratory.

x. The laboratory shall be one certified by MDNR for microbiological analyses.

xi. If the results are acceptable from the first samples (taken on Day 3), a second set of samples will be taken under the direction of the Inspector.

xii. If the results for the second set of samples (taken on Day 4) are acceptable, the laboratory shall provide a hard copy of the lab results to the Inspector.

xiii. If the results are not acceptable from the first set of samples, (taken on Day 3) the Contractor shall follow the procedure shown in the flow chart in Figure 3901-1 to flush and/or rechlorinate the water main until acceptable test results are achieved.

xiv. If the results are not acceptable from the second set of samples, the Contractor shall follow the procedure shown in the flow chart in Figure 3901-1 to re-chlorinate the water main (beginning at Day 1) until acceptable results are achieved.

D. Hydrostatic and Leakage Testing

1. Hydrostatic pressure and leakage testing shall be performed by the Contractor/Developer in the presence of the Inspector and shall comply with current AWWA C600 and C605 procedures for DI and PVC pipe, respectively. The Contractor/Developer shall supply all pipe, tools, and equipment necessary to operate the test.

2. The hydrostatic pressure during testing shall be:

   a. At least 125 percent of normal operating pressure at the highest elevation of the test section.

   b. At least 150 percent of normal operating pressure at the lowest elevation of the test section.

   c. At least 150 psi throughout the test section.

3. The leakage test shall be conducted concurrently with the pressure test. A DIP pipeline is acceptable if the leakage does not exceed the allowable limits as determined by the following formula:

   $$L = SD\,(P)^{1/2}/148{,}000$$

   where

   L = testing allowance (makeup water), gallons per hour
   S = length of pipe tested, feet
   D = nominal diameter of pipe, inches
   P = average test pressure during hydrostatic test, psig

4. A PVC pipeline is acceptable if the leakage does not exceed the allowable limits as determined by the following formula:

   $$L = ND\,(P)^{1/2}/7{,}400$$

   where

   L = allowable leakage, gallons per hour
   N = number of joints in the length of pipe tested
   D = nominal diameter of pipe, inches
   P = average test pressure during leakage test, psi

5. Water mains that fail to meet the test standards shall be repaired and retested, at the expense of the Contractor/Developer, as necessary, until the test requirements are met. Not more than 4,000 feet of main shall be installed without testing.

6. Fire lines shall be hydrostatically tested at not less than 200 psi for 2 hours.

3903 Approved Products List

A. General: An Approved Products List for various materials will be maintained by the City Engineer and updated on a regular basis. An approved list of materials can be found on the City's web site www.cityofls.net. Go to City Government/Departments & Divisions; select Development Services; click on the Design icon; Expand menu for Design Criteria; select Design and Construction Manual (Infrastructure). Direct web link is https://cityofls.net/development-services/design/design-criteria/design-construction-manual-infrastructure